SCIENCE

FRIDAY, OCTOBER 2, 1914

CONTENTS

Address of the President to the Section of Mathematical and Physical Science of the British Association for the Advancement of Science: PROFESSOR F. T. TROUTON 457

The Spirit of a University: DR. MARTIN H. FISCHER 464

Appropriations for the Department of Agriculture 471

The Panama Exposition 477

The Franklin Medal 477

Scientific Notes and News 478

University and Educational News 481

Discussion and Correspondence:—

The Carnegie Foundation for Teachers: DR. A. F. BLAKESLEE. *Jones's A New Era of Chemistry:* PROFESSOR JAS. LEWIS HOWE. *Incomes of College Graduates Ten and Fifteen Years after Graduation:* PROFESSOR HERBERT ADOLPHUS MILLER. 483

Scientific Books:—

Ames on The Constitution of Matter: PROFESSOR R. A. MILLIKAN. *Murray on the Chemistry of Cattle-feeding and Dairying:* E. B. FORBES. 485

Scientific Journals and Articles 487

Special Articles:—

Vitality and Injury as Quantitative Conceptions: PROFESSOR W. J. V. OSTERHOUT. *Soil Acidity and Methods for its Detection:* J. E. HARRIS. *The Stark-Electric Effect:* DR. GORDON S. FULCHER 488

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT TO THE SECTION OF MATHEMATICAL AND PHYSICAL SCIENCE OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

WE have lost since the last meeting of the section several distinguished members who have in the past added so much to the usefulness of our discussions. These include Sir Robert Ball, who was one of our oldest attendants, and was president of the section at the Manchester meeting in 1886; Professor Poynting, who was President of the Section at Dover in 1899, and Sir David Gill, who was President of the Association at Leicester in 1907.

It seems appropriate at this meeting in the city of Melbourne to mention one who passed away from his scientific labors somewhat previous to the last meeting. I allude to W. Sutherland, of this city, whose writings have thrown so much light on molecular physics and whose scientific perspicacity was only equaled by his modesty.

This meeting of the British Association will be a memorable one as being indicative, as it were, of the scientific coming of age of Australia. Not that the maturity of Australian science was unknown to those best able to judge, indeed the fact could not but be known abroad, for in England alone there are many workers in science hailing from Australia and New Zealand, who have enhanced science with their investigations and who hold many important scientific posts in that country. In short, one finds it best nowadays to ask of any young investigator if he comes from the Antipodes.

[1] Section A: Australia, 1914.

This speaks well for the universities and their staffs, who have so successfully set the example of scientific investigation to their pupils.

Radioactivity and kindred phenomena seem to have attracted them most of late years, and it would perhaps have been appropriate to have shortly reviewed in this address our knowledge in these subjects, to which the sons of Australasia have so largely contributed.

Twenty-five years ago FitzGerald and others were speculating on the possibility of unlocking and utilizing the internal energy of the atom. Then came the epoch-making discovery of Becquerel, to be followed by the brilliant work of Rutherford and others showing us that no key was required to unlock this energy; the door lay open.

We have still facing us the analogous case of a hitherto untapped source of energy arising from our motion through the ether. All attempts, it is true, to realize this have failed, but nevertheless he would be a brave prophet who would deny the possibility of tapping this energy despite the ingenious theories of relativity which have been put forward to explain matters away. There is no doubt but that up to the present nothing hopeful has been accomplished towards reaching this energy and there are grave difficulties in the way; but "Relativity" is, as it were, merely trying to remove the lion in the path by laying down the general proposition that the existence of lions is an impossibility. The readiness with which the fundamental hypotheses of "Relativity" were accepted by many is characteristic of present-day physics, or perhaps, more correctly speaking, is an exaggerated example of it.

Such an acceptance as this could hardly be thought of as taking place half a century ago when a purely dynamical basis was expected for the full explanation of all phenomena, and when facts were only held to be completely understood if amenable to such treatment; while, if not so, they were put temporarily into a kind of suspense acount, waiting the time when the phenomenon would succumb to treatment based on dynamics.

Many things, perhaps not the least among them radio-activity, have conspired to change all this and to produce an attitude of mind prepared to be content with a much less rigid basis than would have been required by the natural philosophers of a past generation. These were the sturdy protestants of science, to use an analogy, while we of the present day are much more catholic in our scientific beliefs, and in fact it would seem that nowadays to be used to anything is synonymous with understanding it.

Leaving, however, these interesting questions, I will confine my remarks to a rather neglected corner of physics, namely, to the phenomena of absorption and adsorption of solutions. The term adsorption was introduced to distinguish between absorption which takes place throughout the mass of the absorbing material and those cases in which it takes place only over its surface. If, for instance, glass, powdered so as to provide a large surface, is introduced into a solution of a salt in water, we have in general some of the salt leaving the body of the solution and adhering in one form or other to the surface of the glass. It is to this the term adsorption has been applied. Physicists have now begun to take up the question seriously, but it was to biologists and especially physiological chemists that most of our knowledge of the subject in the past was due, the phenomenon being particularly attractive to them, seeing that so many of the processes they are interested in take place across surfaces.

As far as investigations already made go, the laws of adsorption appear to be very complicated, and no doubt many of the conflicting experimental results which have been obtained are in part due to this, workers under somewhat different conditions obtaining apparently contradictory effects.

On the whole, however, it may be said that the amount adsorbed increases with the strength of solution according to a simple power law, and diminishes with rise of temperature; but there are many exceptions to these simple rules. For instance, in the case of certain sulphates and nitrates the amount adsorbed by the surface of, say, precipitated silica, only increases up to a certain critical point as the strength of the solution is increased. Then further increase in the strength of the solution causes the surface to give up some of the salt it has already adsorbed or the amount adsorbed is actually less now than that adsorbed from weaker solutions. Beyond this stage for still greater concentrations of the solutions the amount adsorbed goes on increasing as before the critical point was reached.

There is some reason for thinking that there are two modes in which the salt is taken up or adsorbed by the solid surface. The first of them results from a simple strengthening of the solution in the surface layers; the second, which takes place with rather stronger concentrations, is a deposition in what is apparently analogous to the solid form. It would seem that the first reaches out from the solid surface to about 10^{-8} cm.—which is the order of the range of attraction of the particles of the solid substance.

The cause of the diminution in the adsorption layer at a certain critical value of the concentration is difficult to understand. Something analogous has been observed by Lord Rayleigh in the thickness of layers of oil floating on the surface of water. As oil is supplied the thickness goes on increasing up to a certain point, beyond this, on further addition of oil, the layer thins itself at some places and becomes much thicker at others, intermediate thicknesses to these being apparently unstable and unable to exist. As helping towards an explanation of the diminution in the adsorption layer we may suppose that as the strength of the solution is increased from zero, the adsorption is at first merely an increased density of the solution in the surface layer. For some reason, after this has reached a certain limit, further addition of salt to the solution renders this mode of composition of the surface layers unstable, and there is a breaking up of the arrangement of the layer with a diminution in its amount. We may now suppose the second mode of deposition to begin to show its effect with a recovery in the amount of the surface layers and a further building up of the adsorption deposits.

On account of passing through this point of instability the process is irreversible, so that the application of thermo-dynamics to the phenomenon of adsorption is necessarily greatly restricted in its usefulness.

A possible cause of the instability in the adsorption layer which occurs at the critical point may be looked for in the alternations in the sign of the mutual forces between attracting particles of the kind suggested by Lord Kelvin and others. Within a certain distance apart—the molecular range—the particles of matter mutually attract one another, while at very close distances they obviously must repel, for two particles refuse to occupy the same space. At some intermediate distances the force must pass through zero value. It has for various reasons been thought that, in

addition, the force has zero value at a second distance lying between the first zero and the molecular range, with accompanying alternations in the sign of the force. Thus, starting from zero distance apart of the particles, the sign of the force is negative or repulsive; then, as the distance apart is supposed to increase, the force of repulsion diminishes, and after passing through zero value becomes positive or attractive; next, as the distance is increased the force diminishes again, and after passing through a second zero becomes negative for a second time; finally, the force on passing through a third zero becomes positive, and is then in the stage dealt with in capillary and other questions.

As an instance, of where these alternations of sign seem to be manifest, may be mentioned the case of certain crystals when split along cleavage planes. The split often runs along further than the position of the splitting instrument or inserted wedge seems to warrant. This would occur if the particles on either side of the cleavage plane were situated at the distance apart where the force between them was in the first attractive condition, for then on increasing the distance between the particles by means of the wedge the force changes sign and becomes repulsive, thus helping the splitting to be propagated further out.

Assuming that a repulsive force can supervene between the particles in the adsorption layer, through the particles becoming so crowded in places as to reduce their mutual distances to the stage when repulsion sets in, we might expect that an instability would be set up.

As already stated, a rise in temperature reduces in general the amount adsorbed, but below the critical point the nitrates and sulphates are exceptional, for rise in temperature here increases the amount adsorbed from a given solution. This obviously necessitates that the isothermals cross one another at the critical point in an adsorption-concentration diagram. This may perhaps account for some observers finding that adsorption did not change with temperature. We have another exception to the simple laws of adsorption in the case of the alkali chlorides; this exception occurs under certain conditions of temperature and strength of solution. The normal condensation into the surface layer is reversed and the salt is repelled into the general solution instead of being attracted by the surface. In other words, it is the turn of the other constituent of the solution, namely, the water, to be adsorbed.

It is a very well known experiment in adsorption to run a solution such as that of permanganate of potash through a filter of sand, or, better, one of precipitated silica, so as to provide a very large surface. The first of the solution to come through the filter has practically lost all its salt, owing to having been adsorbed by the surface of the sand.

I was interested in finding a few months ago that Defoe, the author of "Robinson Crusoe," in one of his other books, depicts a party of African travelers as being saved from thirst in a place where the water was charged with alkali by filtering the water through bags of sand. Whether this is a practical thing or not is doubtful, or even if it has ever been tried; for it is only the first part of the liquid to come through the filter which is purified, and very soon the surface has taken up all the salt it can adsorb, and after that, of course, the solution comes through intact. It is interesting, however, to know that so long ago as Defoe's time the phenomenon of adsorption from salt solutions had been observed. It is not so well known that in the case of

some salts under the circumstances mentioned above, the first of the solution to come through the sand filter is stronger instead of weaker. This, as already mentioned, is because water, or at least a weaker solution, forms the adsorption layer.

Most of the alkali chlorides as the temperature is raised show this anomalous adsorption, provided the strength of the solution is below a certain critical value differing for each temperature. For strengths of solution above these values the normal phenomenon takes place.

No investigations seem to have been made on the effect of pressure on adsorption. These data are much to be desired.

The investigation of adsorption and absorption should throw light on osmosis, as in the first place the phenomenon occurs across a surface necessarily covered with an adsorption layer, and in the second place, as we shall see, the final condition is an equilibrium between the absorption of water by the solution and that by the membrane.

The study of the conditions of absorption of water throughout the mass of the colloidal substance of which osmotic membranes are made is of much interest. Little work has been done on the subject as yet, but what little has been done is very promising.

It is convenient to call the material of which a semi-permeable membrane is made the semi-permeable medium. The ideal semi-permeable medium will not absorb any salt from the solution, but only water, but such perfection is probably seldom to be met with. If a semi-permeable medium such as parchment paper be immersed in a solution, say, of sugar, less water is taken up or absorbed than is the case when the immersion is in pure water. The diminution in the amount absorbed is found to increase with the strength of the solution. It is at the same time found that the absorption or release of water by the semi-permeable medium according as the solution is made weaker or stronger is accompanied by a swelling or shrinkage greater than can be accounted for by the water taken up or rejected.

The amount of water absorbed by a semi-permeable medium from a solution is found by experiment to depend upon the hydrostatic pressure. If the pressure be increased the amount of water absorbed by the semi-permeable medium is increased. It is always thus possible by the application of pressure to force the semi-permeable medium to take up from a given solution as much water as it takes up from pure water at atmospheric pressure.

It is not possible for a mass of such a medium to be simultaneously in contact and in equilibrium with both pure water and with a solution all at one and the same pressure, seeing that the part of the medium in contact with the pure water would hold more water than that part in contact with the solution, and consequently diffusion would take place through the mass of the medium.

If, however, the medium be arranged so as to separate the solution and the water and provided the medium is capable of standing the necessary strain, it is possible to increase the pressure of the solution without increasing the pressure of the water on the other side. Thus the part of the medium which is in contact with the solution is at a higher pressure than that part in contact with the pure solvent; consequently the medium can be in equilibrium with both the solution and the solvent, for if the pressures are rightly adjusted the moisture throughout the medium is everywhere the same.

The ordinary arrangement for showing

osmotic pressure is a case such as we are considering, and equilibrium throughout the membrane is only obtained when the necessary difference in pressure exists between the two sides of the membrane.

This condition would eventually be reached no matter how thick the membrane was. It is sometimes helpful to think of the membrane as being very thick. It precludes any temptation to view molecules as shooting across from one liquid to the other through some kind of peepholes in the membrane.

The advantage in a thin membrane in practise is simply that the necessary moisture is rapidly applied to the active surface, thus enabling the pressure on the side of the solution to rise quickly, but it has no effect on the ultimate equilibrium.

As far as that goes, the semi-permeable membrane or saturated medium might be infinitely thick, or, in other words, there need be no receptacle or place for holding the pure solvent outside the membrane at all. In fact, the function of the receptacle containing the pure solvent is only to keep the medium moist, and is no more or no less important than the vessel of water supplied to the gauze of the wet-bulb thermometer. It is merely to keep up the supply of water to the medium.

The real field where the phenomenon of osmosis takes place is the surface of separation between the saturated semi-permeable medium and the solution. Imagine a large mass of colloidal substance saturated with water and having a cavity containing a solution. The pressure will now tend to rise in the cavity until it reaches the osmotic pressure—that is, until there is established an equilibrium of surface transfer of molecules from the solution into the medium and back from the medium into the solution.

No doubt, the phenomenon as thus described occurs often in nature. It is just possible that the high-pressure liquid cavities, which mineralogists find in certain rock crystals, have been formed in some such manner in the midst of a mass of semi-permeable medium; the pure solvent in this case being carbon dioxide and the medium colloidal silica, which has since changed into quartz crystal.

In considering equilibrium between a saturated semi-permeable medium and a solution there seems to me to be a point which should be carefully considered before being neglected in any complete theory. That is, the adsorption layer over the surface of the semi-permeable medium. We have seen that solutions are profoundly modified in the surface layers adjoining certain solids, through concentration or otherwise of the salts in the surface layer, so that the actual equilibrium of surface transfer of water molecules is not between the unmodified solution and the semi-permeable medium, but between the altered solution in the absorption layer and the saturated medium. Actual determinations of the adsorption by colloids are much wanted, so as to be able to be quite sure of what this correction amounts to or even if it exists. It may turn out to be zero. If there is adsorption, however, it may possibly help to account for part of the unexpectedly high values of the osmotic pressure observed at high concentrations of the solution, the equilibrium being, as we have seen, between the saturated medium and a solution of greater concentration than the bulk of the liquid, namely, that of the adsorption layer. In addition, when above the critical adsorption point, there may be a deposit in the solid state. This may produce a kind of polarized equilibrium of surface transfer in which the molecules which discharge from the saturated medium remain unaltered in amount, but those

which move back from the adsorption layer are reduced owing to this deposit, thus necessitating an increase in pressure for equilibrium. If either or both of these effects really exist, it would seem to require that the pressure should be higher for equilibrium of the molecular surface transfer than if there were no adsorption layer and the unaltered solution were to touch the medium, but at the same time it should be remembered that there is a second surface where equilibrium must also exist—that is, the surface of separation of the adsorption layer and the solution itself. It is just possible that the two together cancel each other's action.

Quantitative determinations of adsorption by solid media from solution are hard to carry out, but with a liquid medium it is not so difficult. Ether constitutes an excellent semi-permeable medium for use with sugar solution, because it takes up or dissolves only a small quantity of water and no sugar. A series of experiments using these for medium and solution has shown (1) that the absorption of water from a solution diminishes with the strength of the solution; and (2) that the absorption of water for any given strength of solution increases with the pressure. This increase with pressure is somewhat more rapid than if it were in proportion to the pressure. On the other hand, from pure water ether absorbs in excess of normal almost in proportion to the pressure. Certainly this is so up to 100 atmospheres. This would go to confirm the suggestion already made that the departure from proportionality in the osmotic pressure is attributable to absorption.

By applying pressure ether can be thus made to take up the same quantity of water from any given solution as it takes up from pure water at atmospheric pressure. It is found by experiment that this pressure is the osmotic pressure proper to the solution in question.

Decidedly the most interesting fact connected with the whole question of osmotic pressure, the behavior of vapor pressures from solution, and the equilibrium of molecular transfer of solutions with colloids, is that discovered by Van't Hoff, that the hydrostatic pressure in question is equal to what would be produced by a gas having the same number of particles as those of the introduced salt. Take the case of a mass of colloid or semi-permeable medium placed in a vessel of water; the colloid when in equilibrium at atmospheric pressure holds what we will call the normal moisture. By increasing the pressure this moisture can be increased to any desired amount. Now, on introducing salt the moisture in the colloid can be reduced at will. The question is, what quantity of salt must be introduced just to bring back the amount of the moisture in the colloid to normal? Here we get a great insight into the internal mechanism of the liquid state. The quantity of salt required turns out to be, approximately at least, that amount which if in the gaseous state would produce the pressure. So that normality can be either directly restored by removing the pressure or indirectly by introducing salt in quantity which just takes up the applied pressure. That this is so naturally suggested that the salt, although compelled to remain within the confines of the liquid, nevertheless produces the same molecular bombardment as it would were it in the gaseous state, though of course the free path must be viewed as enormously restricted compared with that in the gaseous state.

Many have felt a difficulty in accepting this view of a molecular bombardment occurring in the liquid state, but of recent years much light has been thrown on the subject of molecular movements in liquids,

especially by Perrin's work, so that much of the basis of this difficulty may be fairly considered as now removed.

Quite analogous to the reduction from the normal of the moisture held by a semi-permeable medium brought about by the addition of salt to the water, is the reduction in the vapor pressure arising from the presence of a salt in the water. The vapor pressure is likewise increased by the application of hydrostatic pressure, which may be effected by means of an inert gas. In both cases the hydrostatic pressure which must be applied to bring back to normality is equal to that which the added salt would exert if it were in the state of vapor or, in other words, the osmotic pressure.

The two cases are really very similar. In both there is equal molecular transfer backwards and forwards across the bounding surface. In the one a transfer from that solution to the semi-permeable medium and back from it into the solution. In the other a transfer from the solution into the superambient vapor and back from it into the solution.

The processes are very similar, namely, equal molecular transfer to and fro across the respective surfaces of separation.

Thus we may in the case of osmotic equilibrium attribute the phenomenon with Callender to evaporation, but not evaporation in its restricted sense, from a free surface of liquid, but as we have seen from a saturated colloidal surface into the solution. This process might perhaps be better referred to as molecular emigration, the term migration being already a familiar one in connection with liquid phenomena.

F. T. Trouton

THE SPIRIT OF A UNIVERSITY

A decade ago in the United States of America, in a university rated among the first in numbers of students, the professor of astronomy was summoned before the president and the governing board and asked whether he believed the nebular hypothesis which he discussed in a text-book issued under his name. An answer in the affirmative was promised to cost him his teaching position. He answered in the negative, and to prove his sincerity assented to calling in his books and having them burned in public. A less number of years ago a university president whom we to-day honor as a first citizen found it well, or shall we say necessary, to step out of his chosen field of work because he held the minority view among his associates that the word democracy does not mean a political party only. Some months ago a professor of philosophy, teaching its principles as he saw them and under a freedom apparently guaranteed him by charter, alleges his resignation is requested because such teaching in the mind of his president is incompatible with the doctrinal views of an avowedly religious organization operating in some state or states of our Union.

Again, the members of a faculty wake to their accustomed labors and over the coffee and in the newspaper receive first word that their places have over night been declared vacant; a university president demands that his faculty vote Yes or No as an expression of their confidence in him; a faculty member backed by brains and fearlessness rises to condemn most of those time-sanctified institutions of boards of control and university presidents.

It is well to emphasize that these illustrations do not represent hand-picked rarities, but are typical of a class of problems which in greater or less degree arise periodically to clog the machinery of university education. Neither can it be said that a correct solution is not usually found for them. The only question of importance is why the delay in so doing and why so much

of heart burning in the process. The perspective of time answers ever the same—some of those involved, and they may be trustees, presidents, faculty members, or the public at large, have never learned or have temporarily forgotten what constitutes a university.

And what does constitute a university? Time again writes: *It is a collection of men at work solving the problems that our universe presents and standing ready to teach to others the methods of such analysis.*

This definition will doubtless strike many a reader as strangely incomplete. As a first omission will be felt the ignoring of its legal status which in our modern day plays so large a part in the constitution of the university. To understand properly the national, state or municipal aspects of a university we must go back to the original charters granted the original institutions, when we will see in them nothing but the sovereign guarantee of special protection to the workers which constitute the university. The reasons for the necessity of such special protection we shall discuss shortly; but here it is well to ponder for a moment the mere fact. It can hardly be said that such protection of the men of our faculties in America has ever made itself apparent. There are plenty of illustrations to the contrary. Would we find any virtue in the legalization of our privately or publicly controlled universities, we may say that this guarantees a certain protection to the tools with which our faculties work and legal supervision of the custodianship of such things of value which private citizens have at times given to the university to improve the tools of the faculty.

It is well to understand of what such tools consist. They are the records of past workers and the material necessities of the present—among the first, books and such other evidences of its labors as a bygone generation may have seen fit to leave behind; among the second, our buildings and their contents from penwipers and kitchen chairs to tubes of rare gases and janitors. It is entirely in keeping with America's veneration of property rights that legal supervision of the university should be most evident in the protecting hand which it spreads over her material aspects. Some day perhaps our country will attain the standard of the middle ages and extend an equal protection to the men that constitute the university, for, after all, the carpenter's chest is not the carpenter, and while the workman may make him new implements, the rarest tools need hands and minds to guide them.

It is evident from these simple considerations that the sine qua non of a university ever has been and ever must be a group of clear thinking individuals possessed of expert knowledge gotten at first hand. The wobbly logician is useless from the start. Neither does mere possession of much or even expert knowledge make the university type. Teachers in primary grades and the high school are supposed to have as much, and certainly the teaching staff of a technical school. The university man is more than a mere animated manual of useful information in captivity. What we expect of him is not instruction in facts but instruction in methods, and how can he teach others to analyze world problems who has not learned himself?

Let it not be assumed that this obvious point of view so glibly and generally assented to in spirit is as readily adopted in the specific university problem. There is ever a deal of cry for the "practical" man in university instruction who will give our sons and daughters the immediately applicable formulæ for curing headache, shoeing horses, freezing ice cream and raising hay. I am by no means opposed to such

things, only let us not forget what their real place is, and by over-emphasizing them as ends in themselves create in our universities an atmosphere in which a thinking doctor, an engineer who knows principles, a real physiologist or a real agriculturalist can never be made. John M. Coulter has summed it up well: "We are interested in the practical application of knowledge rather than in practical work without knowledge."

It does no harm to try to visualize the university as we have defined it. Its beginnings go back to before the days when the word was born. The shepherd who first distinguished the wanderers from the fixed among the stars breathed its spirit. Socrates and Galileo were good-sized universities in themselves. The academies of the middle ages were the beginnings of the modern, more formal conception of the university. They were collections of men who thought for themselves of matters universal, and taught others how to think. There are some universities in Germany. The name is no guide to them in America. A change in name hardly makes a college, a finishing school or a state-controlled chicken ranch into a university. No doubt degrees may be acquired, and the ambition "to make friends that will be useful in after life," to dress simply and yet expensively, to gain the assurance necessary to live off father's farm, may all be satisfied in many of these places, but is this a university education? With what mixed feelings one reads the autobiography of a Darwin! After two years in Edinburgh and after three in Cambridge he writes, wasted. Only his open holidays stand out when he walked the fields with Henslow and in him found the university. And what shall we say of the institutions usurping the name which for a quarter century allowed Darwin to work at their doors, to achieve that which brought a new salvation, to attain universal recognition, before they themselves invited him in? Must every generation learn anew that a university is not a neat package of fixed ideas, but a place offering sanctuary to unshackled thinking?

A faculty does not, however, constitute the whole university in the minds of the average public. There are boards of trustees, presidents, and we might add, deans, to be considered. Few institutions in the flesh have given rise to bitterer discussion. To understand the why of this and the merits of such discussion we need but recall the history of their development and interpret their acts in the light of what constitutes the spirit of a university.

The best universities, perhaps the only universities known, and the spirit of which every country is busy copying, have no boards of trustees whatsoever, and no presidents. The faculties in them elect each year a dean, and since there is but one of him he might be called a president. But he is not chosen because of his ability to get money for a hard-up institution, to collect or dismiss a faculty, to meet the legislators in the lobby or the well-to-do in their homes, but as an acknowledgment on the part of his confrères of his contributions to the thought of his day. His influence over his faculty is the silent influence of leadership, not the noisy one of accidental power. For trustees in these universities there is no need, for auditing clerks are sufficient to visé bills, the amounts of which may not exceed appropriations originally settled upon when the professor assumed charge. A department is judged by results and not by the neatness of its correspondence files and signed bills.

There was something of this same spirit in the original American universities. There were boards of trustees, but originally

all, and even to a late date many members of such were members of the faculty. The boards had, in other words, delegated to them administrative powers and duties which they could do better than the faculty—clearly a step forward in the terms of efficiency. With time, however, faculty representation in the board became less conspicuous. Originally, the reasons for this were also not bad. A university is the embodiment of certain educational ideals, and it was, of course, to be expected that many not directly connected with a faculty, but interested in the progress of education, should seek opportunity to labor for it. And why should not such labor receive acknowledgment in a position of administrative trust on a university board?

There must have been much of mutual help in a meeting in which men of the outside world brought to cloistered students their practical suggestions, while those within aided the outsiders to catch the ideals of the universities, all presided over by a president chosen for his first-hand knowledge of educational problems. Had things remained so it would have been well for all concerned. But exactly as the past decades found more to admire in the investment banker than in the builder of the road, and more in the squirter of water than in the engineer, so the superintendents and employers of the faculty came to mean more than the output of the university itself.

Excessive attention to the machinery of the university has served to blind us to the obvious fact that it is but a tool and that what we want is more product. There is a law of diminishing returns in the administration of universities as in other forms of activity. In too many spots in our country the administrative tail has wagged and wags the dog. I know the dominant member of a university board who habitually refers to the teaching staff as the hired help. It seems no accident that the strong men of this faculty have found more congenial fields of labor elsewhere. Even national bodies dedicated to the advancement of university education get stung by the efficiency bee. A member of such once classified the engineering branches of our universities on the basis of money spent per student hour. Weaker than the report were the backs of many university attachés which bent under the weight of its fearful authority; nor did stiffness flow back into them until President Maclaurin killed the hundred-and-thirty-page Goliath with a two-page pebble in which he pointed out, what might have been recognized before, that the efficiency of a university is not to be reported on in the same way as the efficiency of "a glue factory or soap works."

It has been urged in extenuation of the gradual acquisition of all administrative powers by trustees and president that such has been made necessary by the weakness of our faculties. Relatively speaking, they have hardly been weaker than many of the superimposed administrators, but in the absolute we have not been so strong as we might. And the reasons for this too are not far to seek. Being so largely ignorant of what really constitutes the spirit of a university, it is but natural that we should have pursued and still pursue a course which keeps a chronically weak-kneed faculty in professorial chairs. In expressing to a friend one day the opinion that the Chinese would one day become a world power, he retorted that he did not think so, because for several hundred years they had not given birth to a new idea. This would, I confess, seal their fate in my eyes were it not for the fact that for these same centuries the Manchus holding sway over them have discouraged all original thinking by the chopping off of heads.

There are a lot of Manchus in our American universities. One of the worst of these is the insecurity of the teaching position held by the professor. It is a tremendous element in the development and supremacy of the German university that her professors are appointed for life and are, to all intents and purposes, not removable for anything short of murder. Big men enlist for such prizes, but not for jobs which terminate automatically every academic year or at the pleasure of a new president or new board of trustees. It will be answered to this that men inadequate for professorial positions must be gotten rid of for the benefit of the university. True, but the way out of the difficulty lies not in the dismissal of professors. The men concerned should never have been appointed to professorships, for assumption of their chairs could hardly be expected to change them much.

But as certainly as our professors should not be subject to dismissal except under the most exceptional circumstances and then only when judged by their peers, equally certainly should there be a quiet burying-ground for the walking dead. The conquest of our universe is the advance of an army, into which many have entered and all should be allowed to, but of which only the picked may live to take final command.

The recruiting of our university faculties begins to-day in the positions for graduate students, fellows and assistants. They form good starting-points and should be as numerous as possible in order to give all those who are called or think themselves called, an opportunity. Of the numerous starters, merit should in due season bring reward to the better ones, and these be made instructors, assistant professors, or, if you please, associate professors. It is in this ascent of the hill that the weak should drop out and under. If properly supervised they might be pushed out and under. It should be understood at all times that a university is not a hospital for the infirm.

Hastily viewed, our present system seems to offer just such opportunities, but in practise an almost opposite result is obtained. It can hardly be said that every one may enter the lists for a university career. On the other hand, once in, the purest bone with long life and robust health may attain a top place. Everything encourages this. If short in virility and long in servility any one may mount in the course of several years from four hundred to a thousand or fifteen hundred. Non-objection to domestic service tempts him into matrimony, and pity for the young couple encourages the raise to eighteen hundred. The third reel tells the story of the rest of this university man's life. He is acknowledged no good, he has not the desire or nerve to quit, and he is not pushed out because he is married. Our universities are full of such men. They are the food of caricaturists and satirists and yet our universities themselves make them. Nor will they become of historical interest only until we stop filling up our teaching bodies with men whose first virtue is their cheapness. The day must come when we will frankly draw a monetary dead line at the point where a man can just live alone and bid him die there unless the character of his work is such that he is accepted into the fold of university-sized men and thereby at once assured decent compensation for a family and life tenure of office. There should be no stepping-stones across this gulf. However agreeable to the chief the placid acceptance of his ideas by the subordinate, however admirable length of service, such do not make the university professor, and university rewards should not be his.

There should, however, be opportunity for the capable university man who has

still to gain the coveted upper place, to work and teach without subserviency. It is unfortunately true that, being human, even great men find virtue in the merely faithful dog, and under the prevailing system of appointment in America, where to stand in with a powerful professor or to be the graduate of the right school means more than accomplishment, such can not help but prosper. And yet it is the less agreeable young worker who thinks independently and differently that we really wish to develop. The situation brings vividly to the front the necessity of lower pitched university positions for which any man may qualify and in which he may enjoy independence and opportunity for individual thinking while receiving as compensation a fixed salary from the university administration or from the students whom he attracts. A university is not alone a collection of clear and new thinking men, but a nursery for such. As one surveys our American institutions as now constituted one wonders how, should they appear, there would fare in them a Voltaire writing "Oedipe" at twenty-two, a Michelangelo carving the young St. John at twenty, a Galileo discovering the isochronism of the pendulum at nineteen.

The American has been accused of being racially without individuality. All the men tighten or bag their clothes in the same season and all the women replace, if so able, felt with straw on Easter day. These things mean in toto a desire to stand with the majority, and it is but natural that to so stand should be considered right, for such view receives constant encouragement in a land where the voice of the many is the voice that rules. It is this view carried into our universities that has done so much to keep us well in the rear. Neglecting for the moment its mischievous consequences from the standpoint of material support and development, for it is not easy to impress the ideals of higher education on a grammar-school mind, this majority view has blinded trustees, presidents, faculty members, and the public at large to the real purposes of a university by demanding that they of it constantly exhale this. But to be of university size its men have very decidedly to voice a *minority* point of view. To believe in and teach the circulation of the blood in 1914 does not make or require a university man. The time for this passed about 1628. Nor will our universities reach a higher level before we have accustomed ourselves as a nation to expect heterodoxy in them and have learned to like it so well that we encourage it. Sovereigns, men of power and of wealth, governments even, have for centuries known this, and spread their protecting hands over the men of their universities to the point even of putting them above the law. It is the blighting influence of the majority demanding that its view be taught in all its schools which has so long made our state and municipal universities lag behind the privately endowed. Democracy owes the latter an unpayable debt in the examples they have given of how to breed and develop that minority point of view which time makes a majority one.

How to encourage this one thing for which our universities exist is well illustrated by those of Germany. Our colleagues there enjoy complete freedom of teaching. It is not expected of them that each shall teach the same thing and in exactly the same way. With us there must be so many hours of this and so many hours of that, all neatly divided according to rules and regulations laid down by the latest college conference. Why not as many hours as possible of that which the man knows best and then another man or another institution for another phase of the same or a

different subject? How can a new point of view come into being or be developed except as we let those whom we have assumed to be able to foster such alone, to spread the new belief with all the power in them? When this day comes men will again call themselves the products of men and not, as now, the products of teaching factories.

But the undertow of interference with freedom of teaching actually goes deeper than this formalism. In Germany even a docent teaches as and what he pleases, and this in spite of all our notions regarding restriction of expression of opinion under European flags. With all our extravagant claims of free press and free speech, our universities are forever debating whether this or that may be discussed in a class room and this or that speaker may use our platforms. Presentation of any living issue, especially if it involves politics, religion or the social sciences, seems tabooed from the start. And yet if subjects with a little less perspective than that given by four hundred years are not the true raw material upon which our universities are to work, what are? Must we forever in practise admit the truth of the father's view in Shaw's play who sends Fannie to Cambridge because he knows that there, if anywhere, will be found alive the atmosphere of the eighteenth century?

We can not leave to anyone's censorship the matter of who and what may or may not be heard in the forum of our universities. We have learned to honor a Luther because he preached the bars down in matters religious; a Jefferson because he preached them down in matters political; a Humboldt because he preached them down in matters educational. The university preaches the bars down for the discussion of all subjects. Those who visit her do not come to be taught a gospel but to use judgment in selecting the best from the gospels presented.

It remains to justify this special protection, this, to some, reckless use of material wealth in support of those who constitute a university. But what need we say of those who have proved themselves the greatest single force for the increase, distribution and maintenance of the one universally desired and valuable commodity—happiness? Can we express in comprehensible values the freedom given the mind by a Newton, a Herschel, a Laplace? Has the public ever paid too much for the blows to superstition of Vesalius, Servetus, Agassiz? Do we remember that for the dynamo and motor and their thousand delightful consequences England never paid Faraday more than twenty-two hundred dollars a year? Was a docent's income too high a price for the Hertzian waves and wireless? Has any one counted up the hours of pain that ether and chloroform have forever abolished? Do we walk daily through pestilence and remember to bend the knee to Pasteur? Shall we detail the millions which a Liebig has added to agriculture? Have we gained anything when the desert brings forth fruits and the swamp something besides death? Will Smith, Laveran, Ross and Reed be even thought of when the boats of a hundred nations push their way through the Panama ditch which the work of these men alone made possible?

If we would further replace intolerance by tolerance, superstition by knowledge, hunger and famine by food, sickness by health and death by life, if we would see happiness where there are tears and blood, the way is clear. A university is not a luxury for the favored of fate. From her cup drink alike and are satisfied sovereigns by the grace of God, aristocrats, bourgeois and proletariat. If gratitude is a

thing of the human heart all classes owe her allegiance. In her the rarest individualist and the broadest communist find common ground. Individuals have freed the many, which, would they remain so, must nourish the fields from which their liberty has sprung. When democracies forget, the individual may rise to do what the many should. A Vilas, a Carnegie, a Rockefeller puts governments to shame. To discover among us the pioneers of thought and to set them at the world's work is university business, and he who does this, be he philanthropist, trustee, president, or faculty member, is a university man.

However uneven the progress of the university, however in innocence or by intent those momentarily in command may chasten her spirit, the need for her will keep her alive. The ever-new problems of an ever-changing universe guarantee this. In the history of our world that religion has always been best which has been newest, because the newest takes greatest cognizance of and tries best to meet the problems of the age in which it is born. Religion invites defeat because it attempts to do more than this by prescribing for all the future which no age and no spokesman for an age can foresee. For the same reason political constitutions ultimately meet amendment or pass out entirely. Our forefathers could hardly draft laws to meet the problems of steam transportation, of telegraphic monopoly, of meat trusts and the thousand other things that our own age has discovered. Only science, which on new evidence will change all her laws over night, is as secure to-morrow as she is to-day. Her spirit is the spirit of the university to which alone the strong will and the weak must forever bow.

MARTIN H. FISCHER

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE[1]

WITH the continued enlargement and extension of the functions of the United States Department of Agriculture, the annual appropriation act providing for its support has become more and more a measure of much public interest. The latest of these acts, signed by President Wilson June 30, 1914, and carrying appropriations for the fiscal year commencing with the following day, is no exception in this respect, again establishing as it does the principle of federal aid to agriculture in the broadest use of the term, providing for the maintenance and development of its manifold activities to a larger extent than ever before, and opening the way to an increased efficiency through a reorganization of its work.

The total amount carried by the act is $19,865,832. This is an increase of $1,878,887, or over 11 per cent. over the previous year, and of $804,500 over the estimates submitted by the department. The increased allotments are distributed throughout the entire department, and while many are designed to provide more adequately for its administrative and regulatory functions, which now absorb nearly two thirds of the total appropriations, opportunity is also afforded for the extension of most of its lines of research, and especially for the development of its various forms of demonstration work.

In its general make-up, the law conforms closely to its immediate predecessor, and in fact is somewhat more rigidly confined to the routine work of the department. There are, however, a number of items of new legislation. Thus, the Secretary of Agriculture is directed to prepare a plan for "reorganizing, redirecting and systematizing the work of the Department of Agriculture as the interests of economical and efficient administration may require." This plan is to be submitted to Congress with the estimates of expenditures for the fiscal year 1915–16, these estimates being arranged on the basis of its provisions. A special object of the proposed reorganization is the elimination of the possibility of duplication, and the securing

[1] From the *Experiment Station Record.*

of close coordination of related lines of work.

Another provision increases the maximum salary which may be paid to investigators or others engaged in scientific work from $4,000 to $4,500. Under the previous limit, a number of the more experienced investigators have been drawn away from the department.

By a clause inserted in the section dealing with the Office of Experiment Stations, funds are given the Secretary of Agriculture to carry out the provisions of the Smith-Lever Extension Act. An extension of the franking privilege is also included under which all correspondence, bulletins and reports for the furtherance of the purposes of that act may be transmitted in the mails free of postage by the college officer or other person connected with the extension department of the college designated by the Secretary of Agriculture, under regulations to be prescribed by the Postmaster General.

Great interest was again manifested in the demonstration and extension activities conducted by the department itself, and some of the largest increases carried in the act are those for their further development. The sum of $400,000 is definitely allotted to farmers' cooperative demonstration work outside the cotton belt, and $673,240 for similar demonstrations in the areas threatened by the boll weevil. In the case of the latter work, a proviso is inserted restricting the expenditures to the funds provided and such cooperative funds as may be voluntarily contributed by state, county and municipal agencies, associations of farmers and individual farmers, universities, colleges, boards of trade, chambers of commerce, other local associations of business men, business organizations, and individuals within the state. The allotment for the campaign against the cattle tick is increased from $325,000 to $400,000, of which $50,000 may be used for live stock demonstration work in areas freed of ticks. There is also an appropriation of $60,000 for experiments and demonstrations in cooperation with states or individuals in live stock production in the cane sugar and cotton districts, and one of $40,000 to aid in the agricultural development of the government reclamation projects by assisting settlers through demonstrations, advice and in other ways.

Most of the various regulatory or police functions assigned to the department receive increased support. The permanent appropriation of $3,000,000 for meat inspection is supplemented by a grant of $375,000, an increase of $175,000 over the previous year. This increase is mainly because of additional work through the inspection of imported meats, in accordance with the Tariff Act of 1913. The meat inspection is also extended to reindeer. The allotment for the enforcement of the Food and Drugs Act is increased by $25,641, largely to meet the additional duties imposed by the recent extension of the act to include meat and meat food products and the amendment requiring the declaration of the net weight in package and similar goods. An increase from $10,000 to $50,000 is provided for the protection of migratory game and insectivorous birds, and one from $75,000 to $100,000 for the cooperative fire protection of the forested watersheds of navigable streams. The appropriation for the enforcement of the plant quarantine act is increased from $40,000 to $50,000, with $50,000 additional to enable cooperation with states quarantined against the interstate movement of Irish potatoes.

As usual there is considerable new legislation relating to forestry matters. The Appalachian Forest Reserve Act of 1911 is amended by increasing the proportion of the gross receipts from the National Forests acquired under its provisions which is returned to the respective states and counties, for the benefit of their public schools and roads, from five to twenty-five per cent. Provision is also made for the handling through the Treasury Department of funds contributed for cooperative work in the protection and improvement of the national forests, as well as for forest investigations, and a requirement is inserted whereby all such contributions must annually be reported to Congress.

The appropriation for studies of the marketing and distribution of farm products is increased from $50,000 to $200,000. Authority

is also given the department for studies of cooperation among farmers in the United States in rural credits and other lines and to disseminate information on the subject, with an appropriation of $40,000 for the purpose.

Other new projects for which definite appropriations are made include $10,000 for the importation of Corriedale and other sheep for breeding purposes; $5,000 for studying the grading, weighing, and handling of naval stores; $7,000 for the publication of reports and maps dealing with the location, extent, etc., of the kelp beds on the Pacific Coast; $10,000 for furnishing official cotton grades and samples to certain associations; $5,000 for the improvement of an additional game preserve; and $5,000 for agricultural extension work in Hawaii. Authority is also given for studies of seismology, a number of new insects and plant diseases, the handling of fish, oysters, and other foods and food products, and the utilization of agricultural products for clothing and other uses in the home. An exhibit by the department, illustrative of farming in the subhumid regions, is provided for the International Dry Farming Congress to be held at Wichita, Kansas, October 7 to 17, 1914, with an appropriation of $20,000 for the purpose.

Considering the appropriations definitely allotted to the several bureaus, that of the Weather Bureau aggregates $1,667,270. This is an apparent decrease of $40,340, but this is mainly because no new observatories are provided except a building at Neah Bay, Washington, to cost $3,000. The allotments of the bureau have been classified on a new basis, $327,270 being available for statutory salaries; $122,000 for carrying on investigations in meteorology, climatology, seismology, evaporation and aerology, and the dissemination of meteorological, climatological and marine information in the city of Washington; $1,189,000 for similar expenses outside of Washington, and $26,000 for the maintenance of a bureau printing office in Washington. The Secretary is also directed to report to Congress relative to the future disposition of the plant at Mount Weather, Virginia, from which the extensive research work formerly carried on is being largely withdrawn.

An increase of $288,830 is accorded the Bureau of Animal Industry, making its total $2,320,026. This is in addition to the permanent annual appropriation of $3,000,000 for meat inspection previously referred to and also to a special appropriation of $600,000, approved February 23, 1914, of which $50,000 was allotted to the inspection of virus, serums, etc., used in the treatment of animal diseases, $100,000 for the investigation, treatment and eradication of dourine, and the remainder for similar work with hog cholera. Among the largest items of increase in the bureau's appropriation are those supplementing the meat inspection funds and for the tick eradication campaign already mentioned, and for work in dairying which receives $256,490, an increase of $78,590. The various items pertaining to animal husbandry are combined into a single group aggregating $182,840, of which $30,000 may be used for the horse breeding project, $24,500 for the poultry studies, including the ostrich industry, and $10,000 for sheep importation. The appropriation for inspection and quarantine work is $625,520, and that for pathological investigations of animal diseases $77,360.

The Bureau of Plant Industry receives $3,616,045. This is an increase of $948,050, about two thirds of which is accounted for by the large additions to the funds for demonstration purposes previously mentioned, and the remainder chiefly by smaller increases apportioned among a large number of projects. The congressional seed distribution is continued on the usual basis and with an appropriation of $257,000, as for the previous year. The bureau also receives $166,500 for the testing and distribution in quantities sufficient for practical field tests of new and rare seeds which from previous trials seem especially promising, and for the improvement of alfalfa, clover and other forage crops, $100,000 of this amount being available for the purchase and distribution of these new and rare seeds. The amount of $74,600 is appropriated for the foreign seed and plant introduction.

Large appropriations are again made for the

prosecution of studies with specific crops. Thus, for cotton $91,000 is provided for an inquiry into ginning, grading, baling, and wrapping practises. This work is extended to include gin compressing and the distribution of the official grades of cotton samples, and the appropriation for testing the waste, tensile strength, and bleaching qualities of the various standard grades of cotton is increased from $10,000 to $60,000. For other fiber plant studies, especially with flax, $20,850 is again allotted, as well as $38,000 for acclimatization and adaptation work with cotton, corn and other crops introduced from tropical regions. The tobacco studies receive $25,000; the cereal investigations $135,405, of which $40,000 is for corn; the studies of grain handling and grading $76,320; those of drug plants $55,380; and those of sugar beets and the production of table sirup and the means of utilizing cane by-products $41,495. For studies in fruit growing, handling and marketing $107,500 is available, together with $56,320 for other horticultural work, and $26,690 for the maintenance of the various departmental greenhouses and the Arlington Experimental Farm.

Another large division of the work has to do with plant diseases, $37,000 being available for the maintenance of the general pathological laboratory and the herbarium of plant diseases, $52,675 for fruit diseases, $69,510 for those of forest trees and ornamentals, and $46,000 for cotton and truck crops. For plant physiology and plant breeding there is allotted $44,540, together with $22,280 for the breeding and physiological study of alkali and drought resistant crops. There is also $35,000 for soil bacteriology and plant nutrition studies, $25,000 for biophysics, $24,000 for economic and systematic botany, $28,700 for studying and testing commercial seed, $5,000 for studies of methods of utilizing logged-off lands, and $230,380 for studies of crop production and land utilization under arid and semi-arid conditions.

The Forest Service receives as usual the largest allotment of any bureau, its aggregate being $5,548,256 as compared with $5,399,679 for the previous year. There are also available the various appropriations under the Appalachian Forest Reserve Act already referred to, certain unexpended balances from the previous year, and an appropriation of $100,000 for fighting and preventing forest fires in cases of extraordinary emergency, this being a reduction from $200,000. The bulk of the appropriation is, of course, to be devoted to the protection and maintenance of the individual national forests, with $400,000 for the construction and maintenance of improvements, $165,640 for reforestation, $140,000 for studies of wood utilization and preservation, $150,000 for forest fire protection, $25,000 for range studies, $83,728 for silvicultural and dendrological experiments, and $40,160 for miscellaneous forest studies and the dissemination of results. The selection and segregation of lands within national forests that may be opened to entry under the homestead laws is to be continued under an appropriation of $100,000, with an additional allotment of $85,000 for the survey and listing of those lands chiefly valuable for agriculture.

The appropriations of the Bureau of Chemistry are increased from $1,058,140 to $1,077,581. The allotment for the enforcement of the Food and Drugs Act is $634,301, with $4,280 additional for the study and inspection of American food exports, $50,000 for studies of the handling and marketing of poultry and eggs, $20,000 for similar work with fish, oysters, etc., $10,000 for biological investigations of food and drug products and their constituents, and $52,400 for general investigations. Because of a transfer to the Bureau of Standards of the work of testing miscellaneous supplies purchased on contract for the various departments of the government, the appropriation for this purpose is reduced from $40,000 to $14,000.

The various lines of work of the Bureau of Soils, and the Bureau of Entomology are continued much as at present, with small increases in a number of items. The Bureau of Soils receives $360,635, an increase of $26,615, of which $11,500 is to extend the inquiry as to possible sources of natural fertilizers, particularly nitrogenous materials. The soil

survey work of the bureau is granted $169,800, with $20,000 additional for the examination and classification of agricultural lands in forest reserves in cooperation with the Forest Service, 15,265 for studies in soil physics, $22,350 for chemical investigations, and $32,700 for soil fertility work. The increase of $87,210 accorded the Bureau of Entomology is divided among its studies of several groups of insects, the largest single item of expenditure being as usual that for the gipsy and brown-tail moth campaign, for which $310,000 is available. The total appropriation of the bureau is $829,420.

The Bureau of Biological Survey is granted $281,290, an increase of $110,300. This appropriation is to be used principally for administrative and police purposes, $66,000 being allotted for the enforcement of the Lacey and McLean laws for the regulation of imports and interstate movement of game, birds, etc., $21,000 for the maintenance of the various game preserves and transfer of game, and $5,000 for the improvement of an additional preserve in Sullys Hill Park, North Dakota. The appropriations for studies of the food habits of birds and mammals and for other biological investigations, however, are nearly doubled, $15,000 being granted for the destruction of ground squirrels on national forests, $5,000 for the study of a serious disease of wild ducks in Utah, $95,000 for the destruction of wolves, prairie dogs and other injurious animals, the rearing of fur-bearing animals, and similar work, and $26,500 for field studies of the distribution and migrations of water fowl and other birds and of the bird and mammal life of the public domain.

The Bureau of Statistics is rechristened the Bureau of Crop Estimates, the new designation representing more accurately, it is believed, the nature of its work and obviating confusion with results based on actual enumerations such as are made by the Bureau of the Census. Several changes are also made in the language prescribing the work of the bureau, and the appropriation at its disposal is increased from $243,680 to $275,580. It is expected that these changes will permit of enlarging the scope and completeness of the data collected, notably as regards special crops and industries.

The various activities of the Office of Experiment Stations are continued and several of its functions are considerably extended. The total appropriation is $1,930,780, of which $1,440,000 is paid to the state experiment stations under the Hatch and Adams acts, and $50,500 (a net increase of $10,720) is for general expenses in connection with the enforcement of these acts and the Smith-Lever Act. The work of the Agricultural Education Service and of the Irrigation and Drainage Investigations is continued on the present basis with allotments of $23,000, $106,400, and $96,280, respectively, and $68,840 is granted for statutory salaries.

The total allotment for the insular experiment stations is $120,000, of which the Alaska stations receive $40,000 and those in Hawaii, Porto Rico and Guam, $35,000, $30,000 and $15,000, respectively. The act provides that of the allotment for the Hawaii Station $5,000 may be used in agricultural extension work, the territory receiving no funds under the Smith-Lever Act. The annual leave privileges of employees of the department permanently assigned to Alaska, Hawaii, Porto Rico and Guam are extended to correspond to those now applying to employees in Washington.

The appropriation for the nutrition investigations of the office is increased from $16,000 to $25,760 and the authority hitherto granted to study means of utilizing agricultural products for food is broadened to include clothing and household equipment. With the enlarged appropriation it is proposed to continue and extend the studies of food with reference to nutritive value and economical use in the home, studying both popular and technical problems, the latter including, among other things, the calorimetric study of changes which take place in fruits and vegetables during ripening and storage. In the case of clothing and household equipment, such questions, considered from the standpoint of the expenditure of human energy, will be studied as the relative durability, economy, and effi-

ciency of comparable materials and articles for specific purposes, the protective power of clothing of different kinds, the relative value and efficiency of different materials and methods with reference to household labor, the relation of the diet to body efficiency, and similar questions. It is believed that the results of such investigations will be of much interest not only to the housekeeper but also to the general public since they will furnish definite information along lines hitherto very inadequately studied but of great importance in the consideration of questions of rational and economical living. They should also be of direct benefit to the farmer since agricultural production is influenced to a very great extent by the demands of the home.

The salary of the director of the Office of Public Roads is increased from $4,000 to $4,500, and the appropriations as a whole from $279,400 to $352,560. The principal increase is one of $40,000 for studies of road building and maintenance, making $145,000 available for the purpose, special emphasis to be directed to the ordinary sand-clay and dirt roads. Increases of $4,800 are also granted for road management studies, $6,260 for tests of road materials, and $15,000 for field trials of various materials, types of construction, and road equipment.

The work of the remaining branches of the department is continued substantially as at present. The increasing administrative work is evidenced in the enlarged allotments for the office of the secretary, rent, and miscellaneous expenses for which $339,880, $108,329, and $110,000, respectively, are available. As a result of recent legislation whereby the administrative auditing of accounts is now carried on in the several bureaus, the appropriation for the Division of Accounts and Disbursements is reduced from $104,370 to $46,320. The Division of Publications receives $189,500 and the Library $45,360.

In connection with the appropriations included in the act itself, reference should also be made to the funds derived in other ways. For the fiscal year under discussion, permanent appropriations under the department aggregate, exclusive of those recently provided by the Smith-Lever Act, $5,999,200, the largest items being those of $3,000,000 for meat inspection and $2,000,000 for the acquisition of lands for the protection of watersheds of navigable streams, and the remainder being almost wholly for forestry purposes. The appropriation act for sundry civil expenses carries an appropriation for the department printing and binding of $500,000, an increase of $10,000, of which $137,500 is for farmers' bulletins and $47,000 for the Weather Bureau.

When it is recalled that large appropriations will also be available for agricultural education in the land-grant colleges under the Morrill and Nelson acts, for the rural education work of the Bureau of Education, demonstration work in agriculture among the Indians, and the payment of the country's quota toward the support of the International Institute of Agriculture, the wide extent to which the principle of federal assistance to agriculture is being carried into practise becomes apparent, and the aggregate expenditure from the federal funds appears increasingly impressive. As was pointed out by Chairman Lever of the House Committee on Agriculture, however, the entire agricultural appropriation is still inconsequential as compared with the total federal appropriations, the magnitude of the agricultural interests of the country, or even of the annual losses to farm products sustained through insect pests and plant diseases.

Moreover, the conviction is deepening that these appropriations are largely in the nature of a permanent investment for the benefit of the nation as a whole. In the words of Hon. C. G. Edwards of Georgia,

> In extending these various benefits and advantages to the farmers we are but doing a simple justice to the sinew and backbone of our great citizenship. In helping the farmers we are helping the whole country, for every class is dependent upon the farmer. . . . We can do nothing that will make for the future welfare of our country more than to aid in this work, which means the establishing of farms and homes. . . . In making appropriations to improve agricultural conditions we are "casting bread upon the waters," that will return not only to feed

the people of this country, but will mean a tremendous increase in our annual farm productions, and will add to the country's wealth, prosperity, happiness and greatness.

THE PANAMA EXPOSITION

PRESIDENT CHARLES C. MOORE, of the Panama-Pacific International Exposition, to open in San Francisco on February 20, 1915, has issued the following statement:

One month ago the decision of the Panama-Pacific International Exposition management not to postpone was first published. The development of events since then, in their relation to the exposition, all tend to confirm the wisdom of that original decision.

At the time the decision was made no word had been received from any foreign nation as to the effect on its plans caused by the European war, but it was hoped that at least those nations not fighting would go on with their plans. Later developments have proven that hope well founded; in addition, we have definite assurances from France, from Italy, from Turkey and from Japan that their intentions are unchanged. Holland has added $300,000 to her original appropriation. Italy has ordered work on her building and exhibits rushed. Japan has asked for and received an increase of space. The Argentine Republic has increased its appropriation from $1,250,000 to $1,750,000.

We shall undoubtedly lose some of the promised exhibits from Europe, but not by any means all of them and not by any means the most important of them. Both Germany and Great Britain will be represented by individual exhibitors or by associations thereof. We shall undoubtedly lose some of the promised entries by European champions in the athletic events, but the international character of those events will not be lost. We may lose some of the art treasures promised us for the Fine Arts Building, but we shall gain others because of the war.

Of compensating gains we have many. There is a very sharp demand for space from the manufactures of this country, of South America and of the European nations not at war. The Exposition suddenly becomes an important factor in an extraordinary economic situation. It is seen to be the one, great, easy, efficient way by which American-made goods can be brought to the direct attention of the distributors and consumers of South America and the Orient. The latter are coming here in force in 1915 to make new individual and commercial connections forced by the war.

As regards attendance, every transportation expert confirms the opinion that a continued European war is likely rather to increase travel to California in 1915 than to reduce it.

The Exposition is 92 per cent. ready to-day. It will open February 20, as planned—and it will be, as planned, the most beautiful and most interesting exposition ever seen. There is no reason to believe that the success of the exposition, in any phase, will be any less than that which was so certain before the European war broke out and it is certain to be even more important commercially than was ever dreamed.

THE FRANKLIN MEDAL

SAMUEL INSULL, ESQ., of Chicago, Illinois, writing under date of December 23, 1913, to the board of managers of the Franklin Institute, Philadelphia, stated that he had been informed it would be a source of gratification to them if the institute had available, in addition to such medals already in its gift, a medal to be known as the Franklin Medal, and to be awarded from time to time in recognition of the total contributions of individuals to science or to the applications of physical science to industry, rather than in recognition of any single invention or discovery, however important. He agreed to provide for the founding of this medal under the following general conditions:

1. That an amount not exceeding one thousand dollars should be furnished by him for procuring appropriate designs and dies for the medal and diploma.

2. That the medal should possess distinct artistic merit, and have on one side a medallion of Benjamin Franklin done from the Thomas Sully portrait in the possession of the institute.

3. That the medal should be of gold and have an intrinsic value of about seventy-five dollars.

4. That the sum of five thousand dollars should be provided by him to be held in trust in perpetuity to be a foundation for this medal, and to be known as the Franklin Medal Fund (founded January 1, 1914, by Samuel Insull, Esq.).

5. That the interest of this fund should be used from time to time in awarding the Franklin medal to those workers in physical science or technology, without regard to country, whose efforts have, in the judgment of the institute, done most to advance a knowledge of physical science or its applications.

6. That any excess of income from this fund, beyond such average annual sum as might be deemed necessary by the institute for the number of medals it is considered best to award, might be used for premiums to accompany the medals.

Mr. Insull said he understood that the institute would be glad to award, on the average, two Franklin medals a year. Though this would leave little surplus, he inserted the sixth condition to prevent an undesirable accumulation of the fund.

At the stated meeting of the board of managers, February 11, 1914, the above offer was accepted, and the medal has been designed by Dr. R. Tait McKenzie, of the University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS

Among the German scientific men who have affixed their names to a manifesto renouncing the honors conferred upon them by English universities and other learned institutions are Professors Paul Ehrlich, Emil von Behring, Ernst Haeckel, August Weismann and Wilhelm Wundt.

Dr. F. M. Urban, professor of psychology in the University of Pennsylvania, is in Austria, and is said to be with the Austrian army.

Dr. David Todd, professor of astronomy at Amherst College and Mrs. Todd, about whom there has been some anxiety, have been reported to be in Petrograd.

Mr. Wenceslas Kotehekow, assistant Russian agricultural commissioner, and Mr. Wladimir Generasoff, secretary of the Russian agricultural agency, have been in this country to study agricultural conditions.

Dr. Benjamin Meade Bolton, of the Bureau of Animal Industry, U. S. Department of Agriculture, sailed from New York for Cuba on August 29, to conduct a campaign for the Department of Agriculture of Cuba against hog cholera.

Drs. Warren A. Dennis, St. Paul; William J. Mayo, Rochester, and James E. Moore, Minneapolis, the committee on cancer of the Minnesota Public Health Association, have been invited to act as the Minnesota state committee on cancer for the American Society for the Prevention and Control of Cancer.

Sir Ernest Shackleton has appointed Mr. Alexander Stevens, assistant in geography at Glasgow University, to be geologist and geographer to the Weddell Sea party of his expedition.

James C. Todd, professor of pathology at the University of Colorado, has been granted leave of absence for the academic year.

The Philosophical Union of the University of California celebrated its twenty-fifth anniversary on August 26, when Professor Josiah Royce gave an address on "The Spirit of the Community."

Professor Frederic S. Lee gave the address at the opening of the present session of the College of Physicians and Surgeons of Columbia University on September 23, 1914, taking as his subject the relation of the medical sciences to clinical medicine.

The Huxley Memorial Lecture at Charing Cross Hospital on recent advances in science and their bearing on medicine and surgery will be given by Sir Ronald Ross, on November 2.

Dr. Morris Longstreth died on September 19 at Barcelona, Spain. On August 29 his wife died also at Barcelona. Dr. Longstreth was born in Philadelphia, in 1846. He was professor of pathological anatomy at Jefferson Medical College, a fellow in the American Association for the Advancement of Science, a member of the American Philosophical Society and one of the founders of the Association of American Physicians.

PROFESSOR CHARLES LADAN ADAMS, professor of drawing and descriptive geometry in the Massachusetts Institute of Technology, died at Antwerp, on September 16, following an operation for appendicitis.

DR. W. H. GASKELL, F.R.S., university lecturer in physiology at Cambridge University, has died at the age of sixty-six years.

Nature records the death of Mr. H. M. Freear, chemical assistant at the Woburn Experimental Farm and pot-culture station of the Royal Agricultural Society, and a leading authority upon the relation of pot-culture experiments to practical agriculture and horticulture.

PROFESSOR B. ALFRED BERTHEIM, member of the Georg Speyer Haus in Frankfort a M., being drawn to join his regiment, lost his life on August 17 at Berlin, in consequence of an accident, at the age of 35 years. The *Chemische Zeitschrift* relates that besides work in alkyl combinations of thallium (with Professor R. J. Meyer) and hydrates of molybdic acid (with Professor Rosenhinn) he has published numerous articles, partly with Professor Ehrlich and Dr. Benda, on nitro- and aminophenyl arsenic acid and their derivatives, on p-aminophenolarsenic oxide, diamino arsenobenzyoles and their derivatives. Professor Ehrlich writes in the *Frankfurter Zeitung,* that to Bertheim belongs the distinction of having accomplished the synthesis of salvarsan. Lately there has appeared from his pen an exhaustive "Manual of Organic Arsenic-combinations."

THE London *Times* reports the death at Sedbergh, of Mr. William Erasmus Darwin, aged seventy-four. He was the oldest son of Charles Darwin, and to his birth may be attributed the origin of a notable department of his father's researches. In his autobiography Charles Darwin says: "My first child was born on December 27, 1839, and I at once commenced to make notes on the first dawn of the various expressions which he exhibited, for I felt convinced, even at this early period, that the most complex and fine shades of expression must all have had a gradual and natural origin." These notes were intended to furnish a chapter of "The Descent of Man," but the importance of the subject ultimately demanded a separate volume—"Expressions of the Emotions in Man and Animals," published in 1872. Four sons of Charles Darwin have attained scientific distinction.

A GIFT of £20,000 has been promised to London Hospital by Mrs. E. S. Paterson for cardiac research work.

BUSINESS and finance in South America are so much affected by the war in Europe that the Chilean minister at Washington has been officially notified that the Pan-American Congress of University Students will not be held at Santiago. It is said that several delegates from the United States are on their way to Chili.

INSTEAD of inaugurating a department of health for Canada, it has been decided that the Canadian Conservation Commission shall look after all health matters in the Dominion. In August the first number of a bulletin was issued to doctors, teachers and others interested in public health work, and will, thereafter, continue to be issued each month.

THE Comité des Forges de France has been obliged to cancel arrangements for an autumn meeting of the British Iron and Steel Institute in France this year. In the circumstances, the council of the institute has decided that it would be advisable to postpone for the present any alternative arrangements for an autumn meeting for the reading and discussion of papers.

THE meeting of the Fourth International Congress on Home Education and the eighth meeting of the American School Hygiene Association scheduled for Philadelphia during the last week in September were postponed. It was considered unwise to hold an international congress at this time. This fact became evident at such a late date as to make it impossible for the American School Hygiene Association to plan an effective independent meeting in place of the joint meeting. The next meeting of the American School Hygiene Association will occur some time early in 1915.

The British Board of Trade has made rules under which a German or Austrian patent may be entirely suspended.

Encke's comet was rediscovered on September 17 on photographs by Professor E. E. Barnard of the Yerkes Observatory. The comet's position was right ascension 3h 43m 40s, declination north 37 degrees, 46 minutes.

The Royal Academy of Medicine of Turin offers its Niberi prize of $4,000 for scientific research in medicine. The conditions may be obtained from the secretary, 18 Vie Po, Turin.

The Chadwick trustees announce their intention to award at the close of this year the Chadwick gold medal and £50 each to the naval and military medical officer, respectively, in the British service who shall have distinguished himself most in promoting the health of the men in the navy and the army.

The commission of the Society of Russian Medical Men, founded in memory of N. L. Pirogov, for the study of malaria in Russia is completing the index of the Russian literature of malaria up to the end of 1913. In future the indexes will be issued yearly, together with short abstracts of the articles, including, if possible, all the literature of malaria for the preceding year. The commission will shortly edit works on leishmaniasis and other diseases due to protozoa and would therefore be grateful to authors of articles relating to this branch of medicine as well as veterinary medicine and phytopathology, if they would send printed copies of their works to the commission. Authors who send two copies of their works will receive the bibliographic index edited by the commission. All communications should be addressed to Dr. E. I. Marzinovsky, Hôpital de l'Empereur Paul I, Moscow, Russia.

The *Journal* of the American Medical Association says the campaign against hookworm in Jones County, Miss., was brought to a very successful conclusion toward the end of August, over 2,500 cases having been treated. Hookworm was found in over 60 per cent. of all cases examined, the largest percentage being found in children. The people showed much interest and cooperated in the work. Many schools were found in which all the teachers and pupils were infected. Much infection in country schools is attributed to the ingestion of the eggs of the parasites in drinking-water obtained from springs near the schools.

Mr. Benjamin F. Groat, hydraulic engineer of Pittsburgh, has secured an unusually high degree of accuracy in discharge measurements on the tests of the large hydro-electric units at Massena, New York, by the use of chemicals introduced into the feed water. The use of chemicals was suggested by Schloesing in France (1863) and has since been employed in England by Stromeyer and in Europe by others in measuring small quantities of water. But by the chemical procedure devised and inaugurated by Groat, very large quantities of water may be measured with a margin of error well within one tenth per cent. Three hundred and sixty tons of common salt and one pound of silver nitrate were employed as reagents during the course of nearly one hundred tests.

According to the *Electrical World,* an electrical device which will indicate the approach of a thunderstorm several hours before any clouds appear is being used successfully by an electric-service company in New York City to give ample time to provide for increased illumination when the thunder clouds darken the sky. The storm-detector apparatus, which resembles wireless receiving equipment, is operated by faint impulses from electrical disturbances in the vicinity. Receiving antennas intercept the impulses, which cause a relay to close an alarm-bell circuit. At first the signals are far apart, but as the electrical disturbance approaches the bell rings more frequently. From an hour to half an hour before the storm breaks, depending on the intensity thereof, the bell will ring continuously. In the meantime steam may be raised to operate generators which are placed in readiness to supply additional energy when the demand increases.

With the cutting off of importations of many mineral products the United States Geological Survey's list of mineral producers becomes an important source of public infor-

mation. In response to specific inquiries addressed to the director of the survey at Washington, concerning the location of mines of any kind tributary to any particular market, extracts can be furnished from this list. The list is not a published one, as it includes about 90,000 names and addresses of producers and is constantly being revised, the changes each year amounting to 25 per cent. of the list. It can be largely utilized, however, in reply to inquiries from consumers of mineral products.

WE learn from the report in *Nature* that the Museums Association celebrated the completion of a quarter of a century's existence at its recent meeting in Swansea. The attendance was large, and the papers dealt in a practical way with the preservation and restoration of works of art—a subject which has never previously received so much attention at an annual conference. Representatives were sent by forty provincial museums and art galleries, five national museums (the British Museum, the British Museum of Natural History, the Victoria and Albert Museum, the National Museum of Wales, and the Museum of the Royal Botanic Gardens at Kew), and the London County Council. The presidential chair was occupied by Mr. Charles Madeley, director of the Warrington Municipal Museum, who in his address invited the conference to consider "What is the true theory of a municipal museum?"

WE learn from the New York *Medical Journal* that the U. S. Senate has passed the amended Harrison bill, under which every person who produces, imports, manufactures, combines, deals in, disposes of, sells, or gives away opium or coca leaves or any combination thereof, or salt or derivative thereof, is required to register annually with the collector of internal revenue, paying a fee of one dollar for registration. This is the measure which had already been passed by the House of Representatives. It is believed that the House will agree to the amendments introduced by the Senate and in that case the measure will no doubt be promptly passed and soon become a law. This bill is a modification of the measure originally drawn up by Dr. Hamilton Wright, commissioner of the United States to the International Opium Congress. The underlying principle is that through the registration of all who are legally entitled to handle these drugs, it will be possible to prevent illegal interstate traffic. This law will supplement the various local laws and through its operation the authorities of the several states expect to be able materially to curtail, if they can not wholly do away with illegal traffic. The measure has been objected to on the ground that it requires the registration of physicians with the internal revenue department. A clause in the law unfortunately permits the sale without registration of domestic and proprietary remedies, containing so-called small quantities of opium and its derivatives.

UNIVERSITY AND EDUCATIONAL NEWS

THE twenty-fifth anniversary of the opening of the Johns Hopkins Hospital, the twenty-first anniversary of the opening of the medical school, the second reunion of the alumni of the medical school and the first general reunion of the alumni of the training school for nurses, will be made the occasion of an elaborate celebration at the hospital, which will open October 5 and continue throughout the week. In connection with the celebration the annual Herter lectures will be given by Dr. Thomas Lewis of University College, London.

THE following gifts to Oberlin College are announced: $50,000 from Dr. D. P. Allen and J. L. Severance, of Cleveland, for completing the new art building; $50,000 from Charles M. Hall, of Niagara Falls, for the improvement of the campus; an anonymous gift of $7,500 for furnishing the new administration building, erected at a cost of $69,500; $25,000 for a new organ in Finney Memorial Chapel, the joint gift of Frederick N. Finney, of South Pasadena, California, and G. M. Hall, of Niagara Falls. The trustees have approved the budget appropriation for 1914–15, amounting to $356,900. Of this sum $194,125 will be received from the term bills of students, $99,300 from endowments, and the balance from sundry sources.

Mr. Robert Brodie Forman, of Liverpool, has bequeathed £10,000 to the University of Liverpool.

Professor R. du Bois-Raymond, writing in the *Berliner Tageblatt*, as quoted in the N. Y. *Evening Post*, says that from Berlin University 236 lecturers, nearly half the total number, are serving their country, either voluntarily or in obedience to the law. The medical faculty furnishes 133 men, presumably for the medical service of the army.

Oxford and Cambridge Universities are opening as usual, but at Cambridge a hospital for the care of wounded in war has been organized on a large scale; Downing College is garrisoned by a hundred nurses, the Medical Schools are housing a contingent, and a wing of the Leys School, the Cloister Court of Trinity and Pembroke College are prepared for the reception of military patients. At Oxford 600 beds have been placed in the Examination Schools.

A committee connected with Oxford University has been formed, with the approval of the Belgian Minister, for the purpose of offering hospitality to professors of Louvain and their families. This committee is composed of the vice-chancellor, the principal of Brasenose College, Sir William Osler, Mrs. W. Max Muller and Miss Price.

Dr. William H. Seemann has been elected dean of the faculty of Tulane University School of Hygiene and Tropical Medicine, and the following appointments to the faculty have been made: Dr. Abraham L. Metz, professor of chemistry; Dr. Andrew G. Friedrichs, professor of oral hygiene; Dr. Isadore Dyer, professor of skin diseases; Dr. Edouard M. Dupaquier, professor of tropical medicine and acute infectious diseases; Dr. Charles C. Bass, professor of experimental medicine and director of the laboratories of clinical medicine, and Dr. Joseph D. Weis, professor of tropical medicine.

Professor Bristol, of the department of bacteriology in the College of Medicine of Syracuse University, has resigned and gone to North Dakota. In his place is Dr. Oliver Wendell Holmes Mitchell from the department of medicine of the University of Missouri, and as his assistant Mr. Ralph R. Simmons, A.M., also from the University of Missouri. Dr. F. M. Meader, associate professor of preventive medicine, has accepted the position as director of the division of communicable diseases in the New York State Department of Public Health. He has, however, retained his position as head of this department and there has been secured as his assistant Dr. Edward D. Clark, for the last three years connected with the health department of Buffalo. Dr. Howard L. Van Winkle, assistant in the Municipal Department of Public Health, has been made instructor in this department and will conduct the work in laboratory diagnosis in the municipal laboratories.

Edwin Burket Twitmyer, Ph.D., has been promoted from assistant professor to be professor of psychology at the University of Pennsylvania. Professor Twitmyer is also assistant director of the laboratory of psychology. Other promotions in the same department are: Francis N. Maxfield, Ph.D., from instructor to assistant professor of psychology; Dr. David Mitchell and Mr. Frank H. Reiter, to be instructors in psychology. Assistant Professor Maxfield will continue, as last year, to be assistant director of the psychological clinic.

Elijah Swift, A.B. (Harvard), Ph.D. (Göttingen), of Princeton University, has been appointed Williams professor of mathematics at the University of Vermont.

Halsey J. Bagg, B.S. (Columbia, '14), has been appointed instructor in zoology in New York University.

DISCUSSION AND CORRESPONDENCE

THE CARNEGIE FOUNDATION FOR TEACHERS—A SUGGESTION

Considerable criticism has been raised in this journal in regard to the method of administration of the pension system for teachers, established by Mr. Carnegie. The purpose

seems to be that teaching only of the higher grade should be rewarded by the foundation. In judging the grade of teaching, however, the character of the institution where the teacher happens to be located, and not the work of the individual teacher himself, is used as the basis of selection. The present note is to suggest for discussion the desirability of changing the viewpoint, and using the work of the teacher, rather than the institution, as the unit of selection.

Success of service in the teaching profession is properly recognized for two main reasons: First, as a reward for past service and, second, as a stimulus for attracting and developing higher grade men in the profession. The reward would be more just if apportioned according to the individual service rendered, and the stimulus would be greater upon such a basis. The indifferent men in accepted institutions may be less worthy of reward and more in need of stimulus than many in unselected institutions.

Undoubtedly one of the chief reasons for making the institution the unit of selection is the apparent relative ease of classifying institutions and administrating the system upon this basis. The difficulties of classifying and administrating upon the individual basis, however, are not insurmountable. The best judge of the success of service in teaching is the opinion of teachers themselves. In "American Men of Science," 1,000 men from the entire body of scientists are listed as of preeminent rank, the number apportioned to each department being in proportion to the total number of scientists that it contains. The essential value of this starred list is the method of its selection. Those starred are thus ranked by the combined vote of the leading scientists in the particular department which they represent. Such a method of selecting individuals could be extended to include all the departments of teaching. The number that the foundation is able to directly benefit can be determined and the list of beneficiaries can then be prepared accordingly, but be selected by the teachers themselves.

Under the present system the value of the pension may seldom if ever be directly discounted from a teacher's salary, but, to the writer's knowledge, the fact of an institution being accepted by the foundation has been offered either as an excuse for a low scale of reward or as an inducement to change institutions without rise in salary. Giving the pension through preferred institutions has little or no influence as encouragement to do better work for those already in these select institutions and, for individuals outside the fold, is of influence only as it causes them to attempt to get upon the preferred institutions even at a sacrifice.

Objection may be raised to the selection of individuals that such a method gives undue prominence to research and publications. In the grade of institutions for which the Carnegie Foundation is intended, research and publication is considered as one of the necessary activities of a good teacher. Publication broadens the class room and increases the number of scholars, making the influence of the teacher international and not merely local. The good teacher further is known by his scholars and by his colleagues. It would be impossible, therefore, for the worthy teacher to escape recognition by a jury of his peers.

It is not desirable to discuss here further the possibilities of the scheme suggested nor to point out the possible influence that a recognized list of teachers might exert upon a more direct adjustment of positions to merit than is at present in vogue in many American colleges and universities. What has been written is sufficient as a suggestion.

A. F. BLAKESLEE

CONN. AGRICULTURAL COLLEGE,
STORRS, CONN.

JONES'S "A NEW ERA IN CHEMISTRY"

TO THE EDITOR OF SCIENCE: The reference to my review of Professor Harry C. Jones's "A New Era in Chemistry," which Professor Franklin makes in his own criticism of the book in SCIENCE of July 31, may serve me as an excuse for a few words regarding this criticism.

Of the exceptions taken by Professor Frank-

lin, the validity of some may be questioned, others are obvious errors which escaped the proofreader and will doubtless be corrected in the future editions the book is sure to demand, while the remainder depend upon the standpoint of the reviewer. It is the latter point to which I wish especially to refer.

If "A New Era in Chemistry" was written as a scientific text-book or as a contribution to scientific knowledge, then any departure from the utmost scientific accuracy of statement would be justly open to criticism, but such is evidently not the purpose of the book. It is rather a singularly successful attempt to give in sparingly technical language a résumé of the salient chemical developments of the last quarter of a century. As such it is of great value, not only to workers in other branches of science, but also to some of us whose work is in other departments of chemistry.

Of course it is desirable that every statement in such a book should be scientifically accurate, and this is a result somewhat difficult of accomplishment, unless the writer takes all the "juice" out of his style by confining himself to a strictly scientific terminology. To take an example: Dr. Franklin is inclined to cavil at the following language: "Radium is naturally radio-active as it is called;" "A radio-active substance is one that gives off radiations" (and then follows in the book a description of the different kinds of radiations). Granted that this language might be objected to in a text-book, it makes the author's meaning clear to the reader, and is obviously permissible in a book of this character.

In other words, the author seeks to convey certain ideas of modern chemistry to readers, many of whom have but limited chemical knowledge, and he does it successfully, even if the language is not that of scientific precision.

Regarding the criticism that Ota "accomplished nothing more remarkable than the measurement of the freezing points of solutions," it is to be recalled that these measurements opened up the solvate theory.

Nor do we think it remarkable that an author, in suggesting the consultation of some fuller work on radioactivity, should refer to his own book on the subject, where full references to the literature of radioactivity may be found.

It is unfortunate that in the popularizing of chemistry as well as other sciences, so few who know, write, and so few who write, know; and one reason, I apprehend, why so few who have competent knowledge, translate that knowledge into language for the people, is because they know it is almost impossible so to do, without exposing themselves to just such criticisms as that of Professor Franklin.

"A New Era in Chemistry" gives evidence of being an enthusiastically written labor of love, and is remarkably successful in giving a living bird's-eye view of the development of the chemistry of to-day. As such, I was glad to commend it—perhaps extravagantly—in my review in the *American Chemical Journal*. Had it been more slowly and painstakingly written, it might have presented fewer opportunities for scientific criticism, but I am sure it would have been far less delightful reading.

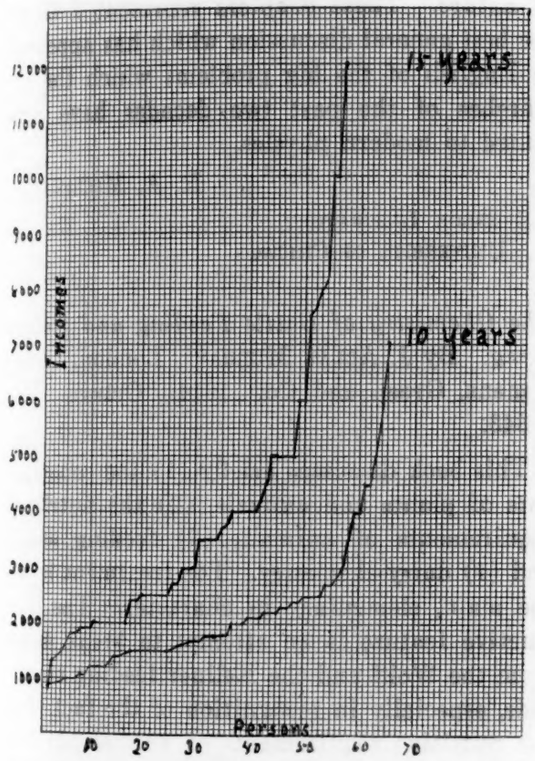
Jas. Lewis Howe

Dune Cottage,
Cushing, Mass.

INCOMES OF COLLEGE GRADUATES TEN AND FIFTEEN YEARS AFTER GRADUATION

Science for February 4, 1910, printed a statement of the incomes of sixty-seven of the hundred men in the Dartmouth class of '99 the tenth year out of college. At the quindecennial reunion last June the net incomes of fifty-six of the ninty-five now living were recorded. Practically all of the fifty-six were included in the group five years ago. Those from whom the facts were not secured undoubtedly would lower the average for the class somewhat, but the two groups are directly comparable. The figures five years ago were used editorially in at least one metropolitan paper to prove the wasted expense of a college education when the earning capacity ten years after graduation was so small. The present figures show that there is a very rapid rise in

this capacity after ten years. Five years ago there were nineteen men getting fifteen hundred or less, this year only four. Then only seventeen per cent. had more than three thousand dollars and last year a little over fifty per cent. were in this class. Five years ago



the highest man had seven thousand dollars and this time the highest was twelve thousand with two tens. Five years ago the average was $2,097 and this time $3,729, with the men at present much more closely massed about the average.

The plat shows the lower line exactly as published five years ago, and the upper line shows the present distribution of incomes.

HERBERT ADOLPHUS MILLER
OBERLIN COLLEGE

SCIENTIFIC BOOKS

The Constitution of Matter. By JOSEPH S. AMES. Houghton Mifflin Co., 1913. 8vo. Pp. x + 242.

This volume represents the 1913 series of lectures, six in number, given at Northwestern University under the N. W. Harris foundation. The purpose of this foundation, as expressed by the donor, "is to stimulate scientific research of the highest type, and to bring the results of such research before students and friends of Northwestern University and through them to the world." It was therefore necessary for Professor Ames, with the above subject, to undertake the extremely difficult task of presenting a true picture of the present status of scientific thought upon the broadest and the most fundamental, though the most dimly discerned, of the fields of science, and at the same time to do it in such a way as to hold the attention of a general audience.

That the lectures actually did command the interest of physicist and layman alike will be testified by all who heard them. Robbed however of the compulsion of Professor Ames's personality I suspect that the printed lectures will make their greatest appeal to the scientist rather than to that type of layman whose taste dictates the popular science of *Harpers, Scribners* and the like. For a careful scientific analysis, such as Professor Ames gives, of the concepts and phenomena which constitute the very foundations of physics, even though divorced, as it is here, from all attempt at mathematical formulation, is something more than the diversion of an idle hour. Indeed many a physicist will ponder long over some of these chapters, and read them more than once, and use them continually for reference as he attempts to put together the rapidly accumulating facts of molecular, atomic and electronic physics into a consistent theory of the constitution of matter.

There are few if any other men whose grasp of both the facts and the theories of physics is sufficiently comprehensive to enable them to discuss with such freshness, thoroughness and insight so many of the problems raised by recent investigations.

Perhaps the most charming feature of the lectures is the clearness and frankness with which Professor Ames reveals his own way of thinking about the problems of atomic and electronic physics and the definiteness of the physical pictures which he calls to his aid. There is no servile restatement of the most striking features of some other physicist's

point of view such as is so characteristic of most popular science writing, but instead a clear presentation of current scientific opinion as it has been incorporated into Professor Ames's own thinking.

The first lecture lays the foundation for the remainder by an admirable and a very discerning historical discussion of the introduction into physics of the concepts of mass, force, the ether, energy, molecules, atoms and corpuscles. Concerning this chapter I would make but two comments: It is a pity that all other writers have not shown as much discrimination in the use of the terms corpuscle and electron. The latter term was introduced into physics in 1891 by G. Johnstone Storey to denote the "natural unit of electricity" *altogether without reference to the inertia which might be associated with it* and it is surely desirable to-day to have some word to denote this idea. *Electron* is obviously the logical word for the purpose. A *negative* electron when associated with the smallest inertia which is ever found to accompany an electron, namely, 1/1830th that of the hydrogen atom, was called by Thomson a corpuscle, and Professor Ames wisely follows this usage. I can not myself be quite so enthusiastic about the statement that "a system has potential energy if it is in its natural condition" or indeed about the way in which the idea of potential energy is used throughout the first and second chapters, especially throughout the second, which deals primarily with the subject of electromagnetic mass. There is a sentence in one of the later lectures which reads as follows: "There is no word, I think, in our language which is so much used to conceal ignorance as 'heat,' and no word about which there is so much confusion of ideas as 'temperature.'" I should like to insert in each clause "*except the word energy.*" The third lecture treats together the newest and the oldest of the departments of physics, namely, radioactivity and gravitation, the former quite briefly (excellent judgment again), the latter quite at length but with a freshness and power which is born only of a very thorough and profound knowledge of original sources.

The fourth, fifth and sixth lectures are the finest and most stimulating of the course. They deal respectively with (4) the problems of radiation, (5) the electron theory of conduction, thermoionics and magnetism, (6) models of atoms and fundamental concepts of nature. These chapters represent I think the best general discussion which has appeared in English of the big problems which the researches of the past two decades have presented to modern physics.

R. A. Millikan

Ryerson Laboratory,
University of Chicago

The Chemistry of Cattle Feeding and Dairying. By J. Allan Murray. London, Longmans, Green and Co. 1914. Octavo. Pp. 343.

This book discusses briefly (1) the constituents of plants and animals, (2) the nutritive requirements of animals, (3) feeding stuffs and (4) dairy chemistry. The treatment is, in the main, elementary in character. The distinctive feature is an attempt to break away from the Wolff and the Kellner feeding standards, especially in recognition of the fact that the nutritive requirements of animals do not vary directly as the live weight. The point of view is rational, and the tentative formulæ suggested for the separate computation of food requirements for maintenance, labor, milk production, growth and fattening constitute a notable step in a direction in which progress is much to be desired. The discussion of the chemistry of the subject is generally satisfactory.

The author's statements regarding the functions of the mineral elements, and regarding other matters of physiology and histology, are frequently lacking in discrimination. We quote a few such passages:

Page 8: "The ingredients of the ash are not 'mineral.' They are just as much organic matter as the fats or proteins."

Page 9: "It is probable, however, that the chlorides naturally present in the food of herbivora are sufficient to provide all the hydrochloric acid required."

Page 10: "Potassium compounds appear to be of minor importance in the economy of animals. They occur in the blood of all herbivora as a necessary consequence of their presence in the food."

"Potassium compounds . . . form nearly one quarter of the ash of milk. . . . A farmer producing milk, therefore, will find it profitable to use potash manures unless his soil is naturally well stocked with that ingredient. Practically the whole of the potash in the food, except what is exported in the milk, is returned to the land in the droppings of the animals."

Page 13: Referring to the ingredients of the ash the author says: "From the point of view of the practical cattle feeder they are all unimportant, inasmuch as they are always present in the natural food of the animals."

Page 15: "Carbohydrates are produced by animals only in insignificant quantities."

Page 46: "Fats do not form part of the tissues of plants as they do in animals."

Page 93: "The composition and properties of lactochrome . . . are quite unknown."

Page 99: "The collagen (of bones) acts as a kind of cement and holds the particles of mineral matter together."

Page 104: "No means is known by which this difficulty (the presence of metabolic nitrogen in the feces) can be overcome; but the amount of such ingredients is probably small and approximately constant. In practise it is ignored."

Page 109: In discussing the absorption of nutrients and their passage into the blood and to the heart, the liver is not mentioned.

Page 132: "This amount (the maintenance requirement of digestible protein) may be estimated, as previously shown, from the amount of nitrogen in the urine which contains all of the nitrogenous products of metabolism."

Much of the matter relative to foods is of local significance and not applicable to the United States, thus (page 255), referring to the storage of ensilage in a silo, "the expense is greater than that involved in the waste of fodder when the silage is made in a stack." "When the expense of a built silo or the alternative loss due to charring at the outside of a stack is added to the losses due to fermentation, it is obvious that silage making is not a profitable method of preserving fodder; and is now rarely practised in this country."

E. B. FORBES

AGRICULTURAL EXPERIMENT STATION,
WOOSTER, O.

SCIENTIFIC JOURNALS AND ARTICLES

THE July number (Vol. 15, No. 3) of the *Transactions of the American Mathematical Society* contains the following papers:

H. F. Blichfeldt: "A new principle in the geometry of numbers, with some applications."

F. R. Sharpe and C. F. Craig: "An application of Severi's theory of a basis to the Kummer and Weddle surfaces."

L. P. Eisenhart: "Transformations of surfaces of Voss."

F. R. Sharpe and Virgil Snyder: "Birational transformations of certain quartic surfaces."

G. M. Green: "One-parameter families of curves in the plane."

G. A. Bliss and A. L. Underhill: "The minimum of a definite integral for unilateral variations in space."

L. D. Cummings: "On a method of comparison for triple-systems."

W. R. Longley: "An existence theorem for a certain differential equation of the *n*th order."

THE June number (Vol. 20, No. 9) of the *Bulletin of the American Mathematical Society* contains: Report of the spring meeting of the society at Chicago, by H. E. Slaught; "On ovals," by Tsuruichi Hayashi; "On the class of doubly transitive groups," by W. A. Manning; Review of Christoffel's Gesammelte mathematische Abhandlungen, by L. P. Eisenhart; Review of Vivanti's Esercizi di Analisi infinitesimale and Dingeldey's Sammlung von Aufgaben zur Anwendung der Differential- und Integralrechnung, by R. C. Archibald; "Shorter Notices;" Heiberg's Archimedis Opera Omnia, volume II., Heath-Kliem's Archimedes' Werke, and Mænnchen's Geheim-

nisse der Rechenkünstler, by D. E. Smith; Study's Konforme Abbildung einfach-zusammenhängender Bereiche, by Arnold Emch; "Notes;" and "New Publications."

The July number of the *Bulletin* contains: Report of the April meeting of the society in New York, by F. N. Cole; Report of the twenty-fifth regular meeting of the San Francisco section, by Thomas Buck; "The ratio of the arc to the chord of an analytic curve need not approach unity," by Edward Kasner; "A Mersenne prime," by R. E. Powers; Review of Osgood's Lehrbuch der Funktionentheorie, by E. B. Van Vleck; "Notes;" "New Publications;" Twenty-third annual list of published papers; and Index of Volume 20.

The October number (Vol. 21, No. 1) of the *Bulletin* contains: "On a small variation which renders a linear differential system incompatible," by Maxime Bôcher; "The smallest characteristic numbers in a certain exceptional case," by Maxime Bôcher; "On approximation by trigonometric sums," by T. H. Gronwall; "Note on the roots of algebraic equations," by R. D. Carmichael and T. E. Mason; "Remarks on functional equations," by A. R. Schweitzer; "Shorter Notices;" Hadamard's Leçons sur le Calcul des Variations, Tome premier, by E. R. Hedrick; Boutroux's Principes de l'Analyse mathématique, Tome premier, by J. B. Shaw; Blumenthal's Principes de la Théorie des Fonctions entières d'Ordre infini, by G. D. Birkhoff; Riesz's Systèmes d'Equations linéaires à une Infinité d'Inconnues, Bowley's General Course of Pure Mathematics from Indices to Solid Analytic Geometry, and Fabry's Démonstration du Théorème de Fermat, by R. D. Carmichael; Silberstein's Vectorial Mechanics, by E. B. Wilson; "Notes;" and "New Publications."

SPECIAL ARTICLES

VITALITY AND INJURY AS QUANTITATIVE CONCEPTIONS

Although a fundamental conception of physiology, the idea of vitality has not been very precisely formulated. This is not only unfortunate from a theoretical standpoint, but it also has practical disadvantages. The physiologist often finds that the validity of his conclusions depends on selecting material of normal validity for his experiments. When he examines organisms for this purpose he is too apt to find that all the tests of vitality which he employs are uncertain or that at best they lack the precision necessary for quantitative work.

An accurate method of measuring vitality seems therefore to be needed not only for more precise formulation of the conception itself, but also for practical purposes.

The investigations of the writer lead to the conclusion that the vitality of a tissue is so dependent on the maintenance of its normal permeability that we may employ the permeability of protoplasm as a sensitive and reliable indicator of its vitality. We may therefore obtain an accurate measure of the vitality of a tissue by carefully measuring its permeability.

This may be accomplished by determining the electrical resistance of living tissues. This method is rapid and convenient for practical use. It may be applied to pieces of detached tissue or to the intact organism.

The writer began the use of this method by cutting disks from the fronds of the marine alga, *Laminaria saccharina,* and measuring their electrical resistance in a manner which has already been described.[1] Subsequently it was found possible to measure the resistance of intact fronds both of *Laminaria* and of other plants by methods which will be described in detail in a future publication.

As the result of his experience with this method the writer concludes that it is often very difficult to judge of the condition of an organism by its appearance. The tissues on which experiments have been made were found to be capable of losing much of their vitality without betraying it in any way by their appearance. (This was particularly the case with eel grass, *Zostera,* which retained its normal green color and appearance for some days after

[1] Science, N. S., 35: 112, 1912.

electrical measurements showed it to be dead.) On the other hand, material of doubtful appearance often turned out to be much better than that which looked to be in sound condition. It seems quite possible that this will be found to be the case with other organisms when quantitative tests are applied.

Material collected in a restricted locality and examined as soon as taken from the ocean gave a very uniform resistance. The same number of disks were used in each experiment, and as the disks were packed together like a roll of coins the length of the roll gave an accurate measure of the average thickness of the disks. To make the comparison as accurate as possible disks of the same average thickness were used in all the experiments. Under these circumstances the resistance at 18° C. did not vary much from 1,300 ohms. For example, in a series of determinations of ten different lots of tissue the highest reading was 1,320 ohms and the lowest 1,285 ohms. These lots of tissue were allowed to remain in the laboratory under different conditions. Some were placed in running salt water while others were allowed to stand in still salt water in pans of various sizes. Some of these were placed in direct sunlight (where the temperature rose to an injurious point) while others were kept in a cool place and sheltered from direct sunlight. At the end of twenty-four hours there was no difference in the appearance of these lots, but their electrical resistance varied from 400 ohms to 1,320 ohms. All were then placed side by side in the same dish. Those with the lowest resistance were the first to die, as was shown by the fact that their resistance fell to the death point (about 330 ohms) and became stationary. The others died in the order indicated by their electrical resistance.

Determinations of the resistance made it evident that in no case did visible signs of death make their appearance until twenty-four hours after death occurred, and subsequent experiments showed that in some cases (especially at low temperatures and in the presence of certain reagents) they may not appear until several days after death.

It was found that material from one locality showed a low resistance and subsequent examination showed that it was contaminated by fresh-water sewage. The appearance of the plants was not such as to lead to their rejection for experimental purposes. They did not survive as long in the laboratory as plants of normal resistance taken from the other localities.

It may be taken for granted that vitality, whatever else it may signify, means ability to resist unfavorable influences. When organisms which are of the same kind, and similar in age, size and general characters, are placed under the same unfavorable conditions, the one which lives longest may be said to have the greatest vitality;[2] the one which lives next longest may be rated second in this respect, and so on. Determination of the electrical resistance of these individuals enables us to predict at the outset which will live longest, which next longest, and so on through the entire group.

Moreover, we find that all influences which impair vitality lower the electrical resistance. It is therefore obvious that determinations of electrical resistance afford a means of measuring vitality and in the course of an extensive series of experiments it has been found that this method may be relied upon to give accurate results.[3]

[2] It might be expected that this individual would also excel in other respects. A discussion of these is unnecessary from our present standpoint: in so far as they can be quantitatively treated they form proper material for a supplementary investigation.

[3] It is evident that the most accurate comparisons will be secured when the tissues or organisms are closely similar in structure, for variations in structure may cause variations in electrical resistance. To compare tissues or organisms which differ in structure (or which for any other reason differ in the absolute number of ohms which expresses their normal resistance) we may use the fall of electrical resistance in a given time under unfavorable conditions (expressed as percentage of the normal net resistance, as suggested below in the discussion of injury) or we may use the speed of recovery from injury of a definite degree. The fall of resistance need not proceed beyond the point at which complete recovery is pos-

The fact that determinations of electrical resistance afford an accurate measure of vitality enables us to attach the same sort of quantitative significance to normal vitality as we attach to normal size or to normal weight. For this purpose we may construct a variation curve and determine the mode in the usual way.

There is no reason to suppose that the vitality of an individual organism is constant any more than its weight is. There is probably some fluctuation which usually passes unperceived unless a quantitative method of detecting it exists. The writer finds that some substances which are normally produced in the organism alter its electrical resistance. Certain reagents may produce marked alteration of resistance without permanent injury. For example, tissue of *Laminaria* having a resistance of 1,020 ohms was placed in NaCl .52 M, which had the same conductivity as the sea water; in the course of a few minutes the resistance fell to 890 ohms, but on being replaced in sea water it rose in the course of a few minutes to the normal amount, where it remained. This was repeated on the same piece of tissue for several days without any sign of permanent injury.[4]

It is therefore evident that considerable fluctuations in vitality may occur without leaving any permanent record.

The determination of electrical resistance makes possible a quantitative treatment of injury. It is obvious that this is as important as a quantitative treatment of vitality. The degree of injury may be defined as the amount[5] by which the resistance falls below the normal net resistance. Temporary injury may be defined as that from which the organism fully recovers, while permanent injury may be defined as that which is not followed by complete restoration of the normal resistance.[6]

From a theoretical standpoint it may be desirable to use in place of the resistance its reciprocal, the conductance.

We may now turn our attention to the significance of this method of measuring vitality and injury. Since the conductivity of the tissue is a measure of the permeability of the protoplasm to ions it is evident that in this method the permeability of the protoplasm is used as an indicator of its vitality. This is in accord with the results of long experience. In doubtful cases it has been customary to determine whether a cell was alive or dead by its ability to contract in a plasmolyzing solution or to resist staining by certain dyes. The diffusion of certain substances out of the cell has long been recognized as a sign of death. All of these are tests of permeability. These criteria have been successfully employed in cases where there was nothing in the appearance of the cell to indicate whether it was alive or dead.

The writer has found that the method of plasmolysis may be utilized to distinguish not only between living and dead cells, but also between cells of normal vitality and those in which vitality has been impaired by certain reagents. In these experiments the reagent was not allowed to act long enough to produce permanent injury.

Lack of space renders it impossible to go into the details of these investigations, but attention may be called to experiments already published which may be interpreted from this point of view.[7] These experiments show that cells recover more quickly from plasmolysis (and consequently have greater permeability) in solutions in which their vitality is impaired.

For example it was found that in sea water suitably diluted a cell of *Spirogyra* when

sible and after recovery the material may be used for experimental purposes. In this way individuals of different species or unlike tissues of the same individual may be compared with respect to vitality. From a theoretical standpoint it may be desirable to use in place of the resistance its reciprocal, the conductance.

[4] Science, N. S., 36, 350, 1912.

[5] This is best expressed as percentage of the normal net resistance; the net resistance is found by subtracting the resistance of the apparatus.

[6] The term injury as used by the writer in previous papers is synonymous with the term permanent injury as here defined.

[7] Science, N. S., 34, 187, 1911.

plasmolyzed to a moderate degree[8] recovered in about twenty-four hours. The *Spirogyra* lives and maintains its normal permeability indefinitely in such dilute sea water.

When placed in a solution of pure NaCl .4 M the vitality of the cell is rapidly impaired and it dies in the course of two or three hours.[9] If such a cell be plasmolyzed by .4 M NaCl to a moderate degree[8] it recovers in the course of half an hour. Since the permeability is inversely proportional to the time of recovery, it is evident that the NaCl impairs the vitality of the cell and at the same time increases its permeability.[10] The two processes go hand in hand. The permeability continues to increase until death occurs, when the cell becomes completely permeable.

These experiments were repeated with a variety of reagents and were afterward confirmed in every detail by the method of determining electrical resistance.

As the result of these and other experiments we may say that the permeability is greatly affected by changes in the composition of the salt solution in which the cell is placed. Normal permeability is best preserved in solutions in which the proportions of salts are approximately the same as in sea water and normal vitality is also maintained longest in these solutions. In general we find that vitality and permeability are affected in exactly the same way by various kinds of electrolytes.

This principle may be applied much more generally. The writer finds that all substances (whether organic or inorganic) and all agents (such as excessive light, heat, electric shock, mechanical shock, partial drying, lack of oxygen, etc.) which alter the normal permeability of the protoplasm shorten the life of the organism. This is equally true whether the alteration consists in an increase of permeability, or in a decrease of permeability (followed by an increase) as is the case when certain reagents (such as $CaCl_2$) are applied.[1] This is a very striking fact and its significance in the present connection seems to be clear and unmistakable. It shows in the most convincing manner that permeability is a delicate and accurate indicator of vitality.

We are unable to say why there is such an intimate connection between vitality and permeability. It is evident that permeability may control metabolism by regulating the osmosis of various substances, and conversely that metabolism may affect permeability. What is needed is not more speculation in this direction, but a careful analysis of the factors which control permeability. If we are successful in determining what these factors are we may hope to arrive at a more satisfactory formulation, in physico-chemical terms, of our conception of vitality as well as of that of injury.

W. J. V. OSTERHOUT

LABORATORY OF PLANT PHYSIOLOGY,
HARVARD UNIVERSITY

[8] This degree is a definite one. It was usually chosen as the condition in which the protoplast just touched the end walls.

[9] This applies only to the species of *Spirogyra* used in these experiments: some species may be more resistant while others are much more sensitive and are killed in less than ten minutes.

[10] In other solutions in which vitality is more rapidly impaired the recovery from plasmolysis is also more rapid and we must conclude that the permeability is proportionately increased.

SOIL ACIDITY AND METHODS FOR ITS DETECTION

THE so-called "acid" soils are peculiar in that a solution obtained by shaking such soils with water will be found, except in rare cases, to be absolutely neutral toward litmus paper. However, if the test paper be brought into direct contact with the soil particles themselves, a very sharp acid reaction will be obtained. These acid soils possess another peculiar property in that if shaken with a solution of some neutral salt such as sodium chloride, an appreciable amount of a soluble acid will be found to be set free.

Two theories have been advanced to explain these properties. The older and perhaps still the most generally accepted theory is the humic acid theory. This theory assumes that there are present in the acid soils, as the result of the decomposition of animal and vegetable matter, some very insoluble organic acids called humic acids. These are supposed to be definite

compounds which react with litmus when the test paper is brought into direct contact with the solid particles and which enter into double decomposition with any salt with which they come in contact liberating the corresponding soluble acid. This latter assumption is rather absurd in the light of our modern ideas of chemistry. The law of mass action is probably one of the most generally accepted laws of chemistry and if we are to accept this law, it is hard to conceive of any acids, as insoluble as these humic acids must be, entering into a double decomposition with a neutral salt such as sodium chloride and setting free such a strong acid as hydrochloric acid. Much experimental work has been done on these humic acids, most of this work consisting of attempts to isolate the acids in a pure form. Experimenters claim to have done this and have even gone so far as to assign definite chemical formulæ to some half dozen of these acids. However, no two experimenters seem able to agree on these formulæ.

Since Van Bemmelen's work on colloids and adsorption, a newer and certainly far more reasonable theory has been put forward to explain the action of acid soils. It is well known that the coagulation of a colloid by a solution of a neutral salt is accompanied by the adsorption of one or other of the ions. If the colloid be electro-negative, it will adsorb the positively charged ion of the salt setting free a corresponding amount of acid. If it is electro-positive, it will adsorb the negatively charged ion setting free a corresponding amount of the base. In the case of the soils, there is present much negatively charged colloidal matter. If deficient in basic material, this colloidal matter is present in a deflocculated condition and is capable of adsorbing the base from any neutral salt with which it comes in contact. Thus if the soil particles are brought into contact with blue litmus, it adsorbs the base of the blue litmus salt leaving the red acid dye on the paper. When shaken with a solution of a neutral salt, the basic portion of the salt is adsorbed leaving a corresponding amount of acid in solution. If the salt used be sodium chloride, the sodium hydroxide is adsorbed and hydrochloric acid liberated.

The acid soils may be divided into two types: first, those found in sandy upland regions, and second, those found in peat or muck lands. The first type has been thoroughly investigated by the writer[1] in the chemical laboratory of the Michigan Agricultural Experiment Station, and he has been able to show that not only is the peculiar behavior of these soils not due to the presence of any true organic acids, but that it is not due to organic matter at all. It was found that soils in which all the organic matter had been destroyed, still retained their acid properties, these properties being due to the presence of colloidal substances, probably hydrated silicates of iron and aluminum. The second type of soils have been investigated by Baumann and Gully[2] who have shown that in the peat soils the acid properties are due to the colloidal matter of the cell covering of the hyalin sphagnum cells.

The remedy for soil acidity is well known. If a soil be treated with lime (either calcium carbonate or calcium hydroxide), the acid properties are destroyed and the soil restored to its former condition of fertility. Many methods have been devised for the determination of the degree of acidity of the soil or, as it is often called, the "lime requirement" of the soil. Most of these methods are based on the old humic acid theory in spite of the fact that this theory has been so thoroughly discredited of late. Such a method was recently described by E. Trugg.[3] The method consists of treating the soil with calcium chloride, zinc sulphide and water. The soil, if acid, reacts with the zinc sulphide liberating hydrogen sulphide which can be detected by means of lead acetate paper. As to the use of the calcium chloride, we will quote from the article:

> The calcium chloride is added to make the test more sensitive. It reacts with the comparatively insoluble soil acids and forms a small amount of

[1] *Jour. of Phys. Chem.*, 18, 355 (1914).

[2] *Mitteilung der K. Boyr. Moorkulturanstalt*, 1910, 31–156.

[3] Science, 50, 246 (1914).

hydrochloric acid which readily liberates hydrogen sulphide from zinc sulphide.

This statement brings out very clearly the absurdity of the position of those who accept the humic acid theory. These humic acids are supposed to be strong enough and soluble enough to liberate hydrochloric acid from calcium chloride, but not strong enough or soluble enough to liberate hydrogen sulphide from zinc sulphide. It is also suggested that this method be made the basis for a quantitative determination of the lime requirement of the soil. The writer does not believe this possible because he has shown[4] that acid soils do not adsorb equivalent amounts of different ions. A determination of the amount of zinc adsorbed by the soil will not tell us the amount of lime to be applied to the soil. Furthermore it is not possible to use a factor to determine the amount of lime to be used from the quantity of hydrogen sulphide given off, because it has been found that the ratio of the amounts of two different ions adsorbed will vary with the character of the soil used. The ratio of the amount of zinc adsorbed to that of calcium will vary with each different sample of soil depending upon the kind of colloidal matter present. The only sure way to determine the lime requirement of an acid soil is to use the same material in the test as is used in the field for correcting the acidity. This is done in the methods of Veitch and Süchting.

As to the qualitative methods for the detection of soil acidity, it has been found that all kinds of litmus paper are not suitable. In fact, in the chemical laboratory of the Michigan Agricultural Experiment Station, Kahlbaum's litmus paper has been found to be the only one not so thoroughly saturated with alkali as to make it unsuitable for this purpose. This litmus paper is so sensitive that it is necessary to leave it in contact with the soil particles only for a moment or two. In this way it has been found that soils only very slightly acid give a distinct test.

J. E. HARRIS

DIVISION OF CHEMISTRY,
MICHIGAN EXPERIMENT STATION

[4] *Loc. cit.*

A SUGGESTION IN CONNECTION WITH THE STARK-ELECTRIC EFFECT

THE discovery last year of the separation of certain spectrum lines when emitted in an electric field has been followed by a remarkably thorough investigation of the phenomenon by Stark and his co-workers.[1] Hydrogen, helium, lithium, calcium, sodium, magnesium, aluminium, thallium and mercury lines have been examined; but only the diffuse, subordinate series lines of hydrogen, helium and lithium show a separation as great as an angstrom for a field intensity of 10,000 volts per cm. The Stark-electric effect differs from the Zeeman effect in that the various lines of the same series are not equally affected, but, for the same field, the separation increases with the number of the term. Stark emphasizes the complexity of the effect, and gives no law for the relative separation of various lines of the same series, though he suggests that a relation should be sought between the relative change of frequency of the various lines and their term numbers.[2]

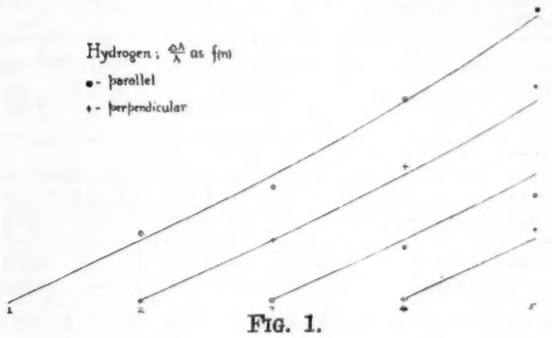


FIG. 1.

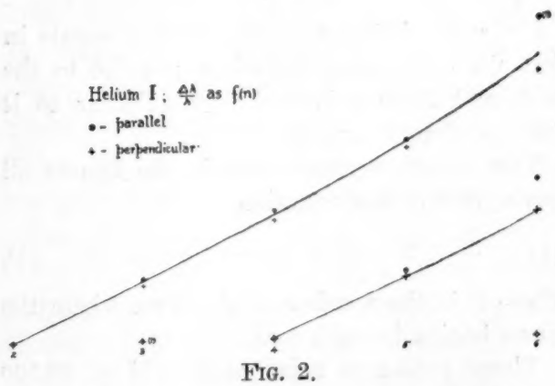


FIG. 2.

[1] *Annalen der Physik*, 43, 965–1047, 1914.

[2] *L. c.*, p. 1033.

From an examination of the data it seems probable to me that the effect is simpler than Stark implies, and that such a relation as he suggests does exist. The relative change of frequency $\Delta n/n$ is equal to $\Delta\lambda/\lambda$, the separation of corresponding, symmetrically placed components divided by the wave-length of the particular line. If we plot this $\Delta\lambda/\lambda$ as a function of the term number, smooth curves drawn through the points are found to agree closely in slope, etc., differing only in the number of the term at which they start. Figs. 1 and 2 show the results for hydrogen and helium I. The numerical data are given in the following table. The numbers in brackets are the term numbers.

$10^3 \times \Delta\lambda/\lambda$ FOR A FIELD OF 28,500 VOLTS PER CM.

Components	Polarization	H	HeI	HeII	Calc.
Outer	Parallel	(2) 1.00	(3) 0.93	(3) 1.05	0.90
Outer	Parallel	(3) 1.68	(4) 1.91	(4) 2.07	1.86
Outer	Parallel	(4) 2.98	(5) 2.96	—	2.94
Outer	Parallel	(5) 4.31	(6) 4.77(?)	—	4.20
Outer	Perpendicular	(3) 0.90	(3) 0.83	(3) 0.93	0.90
Outer	Perpendicular	(4) 1.98	(4) 1.77	(4) 1.85	1.86
Outer	Perpendicular	(5) 3.17	(5) 2.82	—	2.94
Inner	Parallel	(4) 0.79	(5) 1.00	—	0.90
Inner	Parallel	(5) 1.55	(6) 2.36	—	1.86
Inner	Perpendicular	(5) 1.04	(5) 0.91	—	0.90

Hydrogen differs from the other elements in that the components polarized parallel to the field, and those polarized perpendicular to it lie on different curves.

The smooth curves shown in the figures all correspond to the equation

$$(1) \qquad \frac{\Delta\lambda}{\lambda} \times 10^3 = 0.89\ (n-p) + 0.01\ (n-p)^3,$$

where p is the number of the term where the curve begins in each case.

These constants refer to a field of 28,500 volts per cm. Assuming the separation to be proportional to the field, which Stark proved to be true for the hydrogen series, the equation may be written

$$(2) \qquad \frac{\Delta\lambda}{\lambda E} \times 10^8 = 3.1\ (n-p) + .035\ (n-p)^3,$$

where E is expressed in volts per cm.

The reduced separations, $\Delta\lambda/\lambda$, of the HeI lines agree quite closely with this equation; the deviations in the case of the hydrogen lines are larger, but both positive and negative. Curves given by Stark for the variation of the separation with the field strength[3] seem to show a greater accuracy for his measurements than these deviations would imply. Yet a simple curve can not be drawn through the points representing the outer components of the hydrogen lines so as to fit them better than that corresponding to the above equation. And in the reproductions given of the original photographs, the lines are heavy and not parallel and do not seem capable of more accurate measurement.

In the case of helium, the separations for lines polarized parallel to the field were consistently found to be greater than for the corresponding lines polarized perpendicularly. If the effect is real, as it seems to be, the constants of the equation would have to be slightly different for the two sets of components.

In the case of lithium, the reduced separations for 38,000 volts agree with the separations for the corresponding lines of helium. When reduced to 28,500 volts they are a quarter less. The measurements are stated by Stark to be less accurate than for helium, so whether the difference is real remains to be proved. At least the relative separations of the different terms of the series are the same.

It should be stated that as regards asymmetry of position and intensity, the corresponding lines of hydrogen and helium apparently do not behave alike. In fact, Stark reports differences in the behavior of lines of the same series. As he suggests, the very complexity of the phenomenon makes it a most promising field in which to search for clues to a knowledge of atomic structure. It may be too soon to find regularities and the agreements noted above may be accidental. But I think not. If not, they suggest that there is something which is common to the atoms of hydrogen and helium, in addition to the presence of electrons in both.

Gordon S. Fulcher

Wisconsin University,
July 11, 1914

[3] *L. c.*, p. 997.